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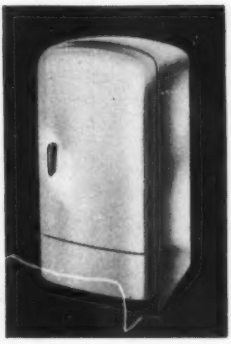

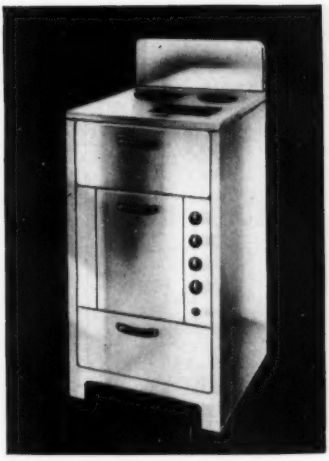

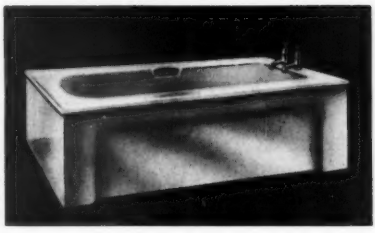

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metal finishing Journal

December, 1956 Vol. 2, No. 24 (New Series)

AN INDUSTRIAL NEWSPAPERS PUBLICATION

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Telephone: Ripley 136

Published on the 15th day of each month by

INDUSTRIAL NEWSPAPERS LIMITED

Chairman and Joint Managing Director:
Barrington Hooper, C.B.E.
Joint Managing Director and Commercial Director:
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Telephone: TRAfalgar 6171 (P.B.X.)
Telegrams: Zacatecas, Rand, London

Subscription Terms:
Home and Overseas 24*s.* per annum prepayable
Single copies 2*s.* (2*s.* 4*d. post free*)

THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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BOY WANTED

THE qualities and characteristics of an industry which render it attractive or unattractive to new recruits to its labour force are very often difficult to pinpoint and define. Factors which are taken into consideration by school leavers when considering their choice of career, include not only the obvious ones such as remuneration and prospects of advancement, but also such less tangible ones as the prestige or standing of the industry in the industrial hierarchy. "Keeping up with the Jones's" plays a more important part in guiding the footsteps of those seeking to make their way in the world than is perhaps generally appreciated by those interested in luring them into their own particular corner of the industrial fold.

The metal-finishing industry, that is to say largely the electroplating and vitreous-enamelling branches of it, has long been aware of the fact that its rate of intake of new labour was insufficient to replace wastage, let alone cater for the current expansion in the industry. Much thought and discussion has been devoted to rectifying this state of affairs, and both the Metal Finishing Association and the Vitreous Enamellers' Association have undertaken the drafting of national apprenticeship schemes as a means of giving status to school leavers entering these two branches of the industry, and assuring them of at least a minimum guaranteed technical training while providing them with some permanent record, in the shape of a certificate or diploma, of their technical qualifications.

The scheme which has been drafted by the Metal Finishing Association in collaboration with the Institute of Metal Finishing and the City and Guilds of London Institute, was presented to the industry at a meeting in Birmingham earlier this month. The scheme was approved by the meeting as being generally acceptable and a national joint Council was set up to progress its implementation and to administer its operation.

Without doubt the operation of an effective apprenticeship scheme which has the full support of the industry and the Educational authorities concerned, is a very valuable factor in the recruitment of labour, and one which is being increasingly required by those entering industry. From this point of view the provision of any sort of scheme must be regarded as a forward step in the right direction, but the necessary criteria, which were referred to earlier, must not be overlooked in this connexion.

The successful operation of such a scheme demands the wholehearted support of, if not the whole, then at least of the major portion of the industry, and it must be fully appreciated by the firms concerned that an apprenticeship scheme does not exist solely as a means of providing them with cheap labour, but that their own responsibilities towards the apprentices in their employ are very real and must be honoured in the spirit and in the deed.

Furthermore, if the scheme is to have any real value, and the qualified apprentice is to take any personal pride in his technical status, careful consideration must be given to the amount of technical training given and the final level which is aimed at. It is not in the best interests of efficient and economic production from an electroplating plant that those responsible for its operation should have but the scantiest inkling of the fundamentals on which the process is based. The industry will be far better served, and the prospects of its adequate staffing in the future will appear far more promising, if every opportunity is taken of upgrading all its operatives to the maximum technical level rather than complacently accepting something considerably lower. It is to be hoped that the significance of this fact will not be lost sight of in the final implementation of this latest apprenticeship scheme to be sponsored by the metal-finishing industry.

Talking Points by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

KEEPING IN STEP

THERE is some doubt as to whether the metal finishing industry has fully grasped the implications of the trend towards mechanisation which is fast gathering momentum in engineering practice. Certainly the machine tool industry has faced up to the fact that the demand which will be made on it for re-equipment will be a huge one, because of the rapidity with which existing plant will become obsolescent. The American Society of Tool Engineers in a recent survey found that in the U.S.A. 16 per cent. of all metal manufacturing processes could be mechanized and that almost one-quarter of all the new machine tools currently on order are for automation. In fact, it has been estimated that 70 per cent. of all machine tools in the U.S.A. are now outmoded.

This means that finishing operations such as degreasing, plating, painting and all the rest will have to fit into the general scheme of things and can no longer remain in obscurity in a quiet corner of the works. Neither is it likely that processes which do not lend themselves to mechanization will long survive, where large outputs are required. While engineering can go quite a long way towards making many operations automatic, there are obvious limits, and for this reason processes and materials which remain obstinate will be tolerated—until something more amenable comes along, as it surely will.

LITTLE LATIN AND LESS GREEK

IT is remarkable that in this country there is still a considerable feeling that a classical, rather than a technical education is the best way of getting to the top. It is this prejudice which is still tending to guide young people away from the Sciences at the Universities, and if one looks at political and Civil Service positions, there seems to be some substance in the contention that technical knowledge may be a positive disadvantage.

The larger and more progressive industrial organizations, however, see in the continuance of this attitude a potential threat to their future in that they may not be able to recruit the best brains to their managements. I.C.I. have recently issued a publication and a series of advertisements, addressed presumably to parents and teachers, to stress the importance of science in the future and the prospects of the scientist with the company. In particular they point out that 12 out of the 17 of their full time directors are science or engineering graduates, as are the holders of 160 out of the 254 most important senior positions in the company. These are impressive figures, but no one would say that they are anywhere near typical of industry in this country as a whole. I.C.I. is of course, a highly successful company, and one might draw the obvious conclusion .

PACKETS OF TROUBLE

ALONG overdue reform is the likelihood that we may soon see a change in the Truck Acts which will enable firms to pay wages by cheque instead of in cash. A century ago such protection was necessary for workers who sometimes received a sack of flour or a few hens from a farmer in lieu of wages, a practice against which they had no redress. Nowadays, however, the chore of drawing cash from the bank and making up millions of pay packets seems to be a very wasteful activity. When the risks of robbery when large sums of money are being carried, and the frequent arguments which occur about the contents of pay packets in most works are taken into account, the argument for reform becomes decisive.

Recently one large firm introduced a cheque system and had a very successful run, having made arrangements for local traders to accept and change their wage cheques. They had to discontinue the scheme, however, when advised by their lawyers that they were acting illegally by paying wages in this way.

To have mechanized accounting and wage packets put up by hand existing side by side is absurdly anachronistic.

ANOTHER NEW "POLY"

BIG advances are coming in the plastics field which will certainly be of great value in helping to reduce corrosion problems in the electroplating industry. Polythene, although very useful, suffers from the great disadvantage of becoming soft at around 65° C, so that it cannot be used at temperatures approaching that of boiling water. The newer polythenes made by the Ziegler and other processes are better as they melt at about 120° C, and do not lose much of their mechanical strength at temperatures of up to about 90° C. The latest development, however, is polypropylene, the method of manufacture of which has been successfully worked out by Montecatini in Italy. This material melts at no less than 160° C.

It is said not to be waxy like polythene, in which case it might be capable of being bonded to steel, which would be tremendously useful.

A Survey of Recent Developments in HOT-TINNING

by C. J. THWAITES, M.Sc., A.R.S.M., A.I.M. *

THE PROCESS of hot-tinning, that is to say coating a metal by immersion in a bath of molten tin, has been in use for very many years and is still used widely on both a large and a small scale in many engineering and other workshops. The term "hot-tinning" not only applies to the use of pure tin as a coating material, but also to the use of tin-lead solders or more complex tin alloys. In addition, there are the wiping techniques commonly used for tinning selected areas or the insides of hollow vessels. Hot-tinned coatings are generally applied to certain fabricated articles as a protective and decorative finish. Domestic mincing machines, milk transport cans, milk-handling equipment for dairy use, kitchen utensils, and general hardware, are normally finished by hot-tinning. The coating may also be an aid to further assembly operations such as soldering, on partly completed articles, like radio chassis and electrical connectors, while bearing shells are tinned prior to lining with a bearing alloy.

In 1950, a booklet [1] describing recommended procedures in hot-tinning, was published by the Tin Research Institute. The present article discusses current practice and some developments which have occurred since this publication appeared, and various operations in the tinning process will be discussed in the order in which they are normally carried out in practice.

Degreasing

Removal of surface grease, oil, or drawing lubricants, from articles to be hot-tinned must be complete to obtain satisfactory coatings. Degreasing may be carried out by either vapour or liquid solvent methods or alternatively by hot alkaline cleaning solutions.

Certain articles, such as hollow vessels with a narrow opening at one end only, may not be thoroughly degreased internally by vapour, since the air cannot be displaced from the inside. In these cases, immersion in hot alkali is preferable, and manual treatment with mops and brushes may be advantageous. A combination of vapour degreasing followed by hot alkali may also be necessary for particularly thick or tenacious coatings of grease.

Many cases of poor tin coatings may be traced to imperfect degreasing in the first instance, which prevents or retards attack on the steel surface during subsequent pickling. The importance, therefore, of leaving no traces of grease on the surfaces before pickling and tinning, cannot be over-emphasized.

Pickling and Etching

There are two distinct stages in the preparation of metals with acid prior to hot-tinning, the first being oxide removal and the second being etching of the surface to make it accept the molten tin readily and rapidly.

Generally, either cold hydrochloric acid or hot dilute sulphuric acid is employed for the preparation of steel and sufficient time of immersion is given to allow both oxide removal and etching of the surface to occur. Hydrochloric acid is considered to give a cleaner etched surface than sulphuric acid, although considerably longer pickling times are required. Provided that steel surfaces are cleaned free of rust by a preliminary treatment in hydrochloric or sulphuric acid, subsequent etching may be done solely with nitric acid, although this reagent is usually reserved for the tinning of "difficult" steels, as discussed later. It has the advantage, however, that the rate of attack is fast, thus enabling a short preparation cycle to be obtained.

Nitric acid may be used in any dilution, but preferably between 10 and 25 per cent. by volume. About 2 to 3 minutes in 25 per cent. or 7 to 10 minutes in 10 per cent. is quite adequate, both

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Fig. 1.—A continuous spray-pickling unit from the entry end. At the far end, the article emerges pickled, rinsed, neutralised and dried, ready for tinning or other processing. (Courtesy Edward Curran Engineering Co.)

solutions being at room temperature. With the greater dilution mentioned, there is less tendency for the formation of nitrous fumes. In either case, the fumes obtained during the etching of steel are no more objectionable than those from a hydrochloric acid bath, and in all places where vats of acid are in regular use, adequate fume extraction is essential. The acid may become warm with constant usage, giving rise to excessive fuming and difficulty in controlling the amount of etch obtained. Water-cooling of the vat is then advisable. During etching the steel becomes covered with a thin, "syrupy" layer, deep brown in colour, which is difficult to remove by an ordinary swill in running water. It is essential to remove this layer before tinning, to avoid carryover of iron salts to the flux dip and thus into the tin bath. A high pressure spray rinse is advantageous but, more simply, the layer is instantly dissolved by a brief dip in dilute hydrochloric acid. Thus, a normal sequence of operations would be—(1) Rust removal in hydrochloric acid pickle; (2) Etch in nitric acid; (3) Re-dip in hydrochloric acid—each operation occupying only a few minutes.

A reagent which has also been found to give a rapid etch to an oxide-free steel surface, in a similar manner to nitric acid, is ferric sulphate liquor. A cold solution containing 20 per cent. of this salt by weight will produce rapidly an etched surface suitable for tinning. The solution has the advantages that it is non-acid (although corrosive of course), non-fuming and causes no hydrogen evolution and hence eliminates the danger of blistered tin coatings. For normal pickling, it is mixed with sulphuric acid and used warm, usually giving a cleaner surface than hot sulphuric acid alone.

In batch pickling practice, the acid bath must be large enough to enable the tinner to be kept continually supplied with pickled work. For a larger production of articles, the relatively recently developed technique of spray-pickling has been used. Normally such units are employed in vitreous enamelling and similar plants, but instances are known where they are used successfully for the preparation of milk cans and frying-pans for tinning. Fig. 1 shows a typical spray-pickling unit in which he articles are carried on an acid-resistant conveyor-belt through cleaning, pickling, rinsing, neutralization and, if required, drying sections and emerge ready for further processing. Hydrochloric acid is most suitable for such plants as it may be employed at room temperature. At relatively high dilutions, the pickling times required under these conditions are considerably less than in normal immersion pickling, presumably due to the easy access of oxygen to the surface being attacked and to erosion effects resulting from the fast moving droplets of acid. Using hot sulphuric acid, it is difficult to ensure that the acid spray is at a sufficiently high temperature when it reaches the steel surface after travelling at high velocity some feet through cool air. As far as it is known, nitric acid has not been employed in spray-pickling. It is probable that extremely short etching times would be obtained even with very dilute nitric acid in view of the effect of agitation shown by Hedges[2]. The rate of attack was increased for metals electro-negative to hydrogen (tin and iron), and decreased for those electro-positive to hydrogen (copper and silver).

One of the major factors to be considered in the hot-tinning of steel is the quality of the basis material. A tinned finish of pleasing appearance

will only be obtained if the underlying steel surface is smooth and free from defects. In recent years there has been a great increase in the proportion of cold-reduced steels available, which are superior in mechanical properties and surface-finish to their predecessors from the hot mills. It is known that they may cause intermittent difficulty in hot-tinning and may thus be classed in some instances as "difficult" steels. The difficulty arises from the contamination of the surface of the steel sheet by rolling lubricants. In themselves these oils may not cause trouble, but subsequent annealing causes breakdown of the complex oils to form a molecular layer of carbonaceous matter which prevents or retards the action of pickling acids on the steel. The result is that the steel is inadequately prepared for tinning and the defect, commonly referred to as "dewetting" arises. Similar difficulties may arise in articles manufactured by a deep-drawing or spinning process, from steel of excellent tinning quality, due to the forcing into the surface of the lubricants or soaps employed during fabrication. Not infrequently, full scale tinning experiments, as illustrated in Fig. 2, have to be carried out in the hot-tinning laboratory of the Tin Research Institute on articles exhibiting "difficult" tinning properties. A typical example of this defect may be observed in some types of milk transport cans, which are made by welding deep-drawn or spun neck and bottom sections to the cylindrical body. During the manufacture of milk cans, the body is only slightly deformed and may tin perfectly while dewetting of the coating occurs on the drawn components. Prolonged immersion in hydrochloric or hot sulphuric acid baths may, in some cases, eventually overcome the difficulty, but the more reactive surface of the body will be severely roughened in the process. Nitric acid will generally destroy such non-reactive surfaces because of the inherent oxidizing nature of the acid. Since the necessary times of immersion in this acid are relatively short, only a slight amount of over-etching is obtained on the body, and this may be tolerated since the tin coating will cover up such slight roughness.

In many modern plants a vat of nitric acid is available to deal with "difficult" steels. Such a plant is shown in Fig. 3, where a large, hollow, steel vessel has just been removed from the nitric acid vat before being taken to the tin bath at the far end of the line. Full details of this plant are given in a recently published article([3]).

Another technique for the treatment of "difficult" steels is to remove the entire surface by a short oxidation treatment at high temperature. Normally, the articles are dipped in used pickle liquor or dilute ammonium chloride solution before being passed into an air furnace at about 800° C. A period of about 20 minutes is sufficient to form a friable scale on the surface. On removing the articles from the furnace, the scale may be assisted to break free from the surface by quenching from below red-heat and a normal pickling treatment will remove any residual oxide. Unfortunately, some surface contaminants are not readily destroyed at temperatures below which the steel components are softened or distorted, and in such cases the previously mentioned method of etching with nitric acid has to be resorted to.

Some tinners allow articles to rust in the atmosphere, after degreasing, for a considerable period before attempting to tin them. This procedure may lead to undue roughness of the surface on those parts most exposed to the weather, while "difficult"

Fig. 2.—Tinning experiments in progress on milk cans in the hot-tinning laboratory of the Tin Research Institute.

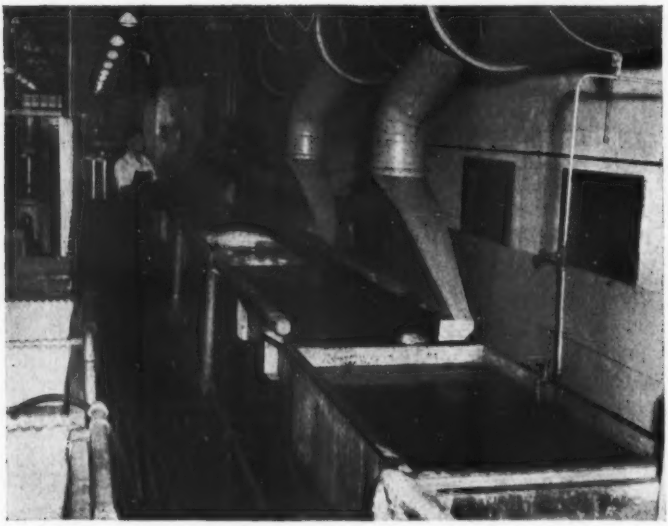


Fig. 3.—A modern tinning plant showing a large hollow vessel being removed from the nitric acid etch. The next nearest vat is the hydrochloric acid pickle, while in the foreground is a running cold water rinse tank. (Courtesy Tecalemit Ltd.)

surfaces produced, for example, by deep-drawing, may be resistant to rusting. Generally, rusting is accelerated by dipping the articles in a dilute chloride solution or used pickling acid, followed by weathering in the open. One plant is known where the articles are dipped in a suitable solution and subsequently stored for a fixed period in a special humid room. Alternatively, it is possible to use a rusting solution, the articles becoming coated with rust while completely immersed. A solution used occasionally in the laboratories of the Tin Research Institute for this purpose has been devised which contains the following:—

Ammonium chloride	5 lb.
Hydrogen peroxide (10 volume) ...	2 pints
Water	10 gall.

This solution, however, does not appear to attack surfaces which have been affected by drawing or rolling lubricants.

Pickling solutions should always be chemically controlled, but it is often left to the discretion of the pickler to decide whether the acid requires making up to strength. It is a relatively simple matter to carry out volumetric analysis of such solutions to determine acidity, but in many cases there is not sufficient time or facilities to carry out these tests. Determination of the specific gravity affords some control, but is not really adequate.

A novel method of control for nitric acid, measures the potential developed between the pure aluminium vat and an insoluble reference electrode, the voltage indicating the condition of the acid.

It has been shown by Hansen and Lindsey[4], Winterbottom and Reed[5], and Jackson, Stedman and Riley[6], that the effectiveness of the acid decreases as the iron in solution becomes higher even with constant acidity. Determination of the iron content of pickling baths is hence important. Normal analysis may be carried out in a chemical laboratory for acid and iron content, but pickle bath test sets are available which are simple to use and require no skilled operator: a prepared tablet of reagent is added to a sample taken from the bath in a graduated glass vessel and the acid or iron content may be read off at will. The whole operation may occupy only a few minutes and much trouble may be saved, by a routine test such as this, in avoiding defects on articles inadequately prepared for tinning. Recently published work[7] has shown that many metallic impurities, besides iron, may have inhibiting effects on the dissolution of metals in acid. In view of this effect the pickling, before re-tinning, of already coated articles or of components containing, for example, brazed joints, must be carefully undertaken. For troublefree working, all pickling operations should be carefully controlled and steps taken to avoid contamination of the vats with excessive metallic impurities.

After pickling, articles are normally rinsed and then dipped in an aqueous flux solution before being immersed in the molten tinning bath through a blanket of fused flux.

Fluxes and Fluxing

In hot-tinning, the flux may be considered as an agent which facilitates and speeds the reaction of the molten tinning metal with the solid basis metal. The formation of a continuous thin layer of tin-iron, tin-copper or other intermetallic phase, on which the liquid coating can spread in an even, smooth and continuous film is thus promoted.

Fluxes are used in hot dip-tinning in two different ways. First as aqueous solutions in which the work is dipped before it is immersed in the

molten metal; second as a molten layer on the top of the molten metal.

The dip in the pre-fluxing solution serves two purposes: first, to carry a film of water over into the fused flux cover or blanket on the molten tin, an essential for good tinning; second, to coat the article with the necessary fluxing salts to prevent oxidation of the clean, pickled surface and to replenish the salts in the flux blanket. The basis of most fluxes used in hot-tinning is zinc chloride, and indeed, this is quite commonly used by itself. It is relatively cheap in a commercially pure crystalline form, can be applied directly to the surface of the tin bath to obtain a molten flux cover, and can be readily dissolved in slightly acidified water to make a pre-fluxing solution. Some tinners still prefer to make their own zinc chloride by the old method of neutralizing hydrochloric acid with zinc metal, forming the so-called "killed-spirits". Excessive acid often remains, giving an inferior and unreliable product not recommended for good hot-tinning practice. Zinc chloride alone is not an ideal flux since the close proximity of the melting-point to normal hot-tinning temperatures causes undue viscosity of the flux blanket, which may then cling to articles being withdrawn from the molten tin. It is thus advantageous to employ a mixture of chlorides to obtain the necessary fluidity and activity. Many fluxes contain ammonium, sodium, potassium and other chlorides with minor additions such as zinc oxide or carbonate to decrease water absorption by the salts during storage. Many trial experiments

Fig. 4.—Applying water in a fine spray to activate the flux blanket on the rough-tinning bath at 300° C prior to tinning cast iron by the Direct Chloride method. (Courtesy G.E.C. Ltd.)

Fig. 5.—Transparent splash guard on entry side of tin bath in which frying-pans are being tinned. (Courtesy Joseph Sankey and Sons Ltd.)

in the laboratories of the Tin Research Institute have shown that a flux of the following composition is suitable for most general purposes and, in particular, for the tinning of steel and cast iron:—

Zinc chloride	... ...	73 per cent.
Sodium chloride	... ...	18 „
Ammonium chloride	...	9 „

This flux does not cake after long periods of use. When the flux eventually becomes less active, indicated by lack of frothing during immersion of the wet articles, it may be renovated by the addition of small quantities of water. The water is applied preferably by means of a fine spray, as shown in Fig. 4, since there is less danger if the water accidentally comes into direct contact with the molten tin. This activation of the flux blanket is particularly important when operating the Direct Chloride process for tinning cast iron, which is described later. It is thought that the ammonium chloride content of the flux is responsible for the high activity and it has been found that little of this substance is lost during tinning. It is also interesting to note that there appears to be virtually no increase in tin or iron content during the same period.

Another flux blanket which has been tried and shows great promise contains:—

Zinc chloride	... ...	75 per cent.
Ammonium chloride	...	12½ „ „
Stannous chloride ...	...	12½ „ „

This is based on the well-known fact that the addition of tin salts may be beneficial in soldering fluxes. The fluidity of this mixture is greater than that of the one previously mentioned but, of course, it is rather more expensive owing to the presence of the tin chloride.

Pre-fluxing solutions, corresponding to the flux-cover compositions just given, can be made by dissolving 30 to 40 lb. of the mixed salts in 10 gallons of water containing about one pint of concentrated hydrochloric acid and not more than 0·25 per cent. of an acid-stable wetting agent.

It is important that a pre-fluxing solution is kept in good condition and the iron content should be checked regularly, otherwise iron will be carried over and will contaminate the tin bath. Determination of the specific gravity is generally a good indication of the state of the solution. However, drag-out of flux solution is normally high and by constantly making up to the required volume, little trouble is encountered.

Having been adequately degreased, pickled, etched and fluxed the articles are immersed in the tin bath.

Tinning

Provided that the foregoing preparatory treatments of the basis metal have been carried out correctly, there is little difficulty in obtaining a perfect coating by immersion in the molten tin bath. In tinning steel, the first or rough-tinning bath is usually maintained at 300° C, if a second dip is to follow at a lower temperature, or at about 280° C for single-pot tinning. The latter temperature is also used for dipping copper-base material In either case, a flux cover is employed which, to a certain extent, minimizes spitting when the wet articles are immersed. However, some form of protective screen on the entry side of the pot is a good safety precaution and a glass screen for this purpose is illustrated in Fig. 5. In addition, the operators should be adequately clothed and, in particular, long gloves should be worn. Asbestos gloves are suitable but tend to be destroyed by splashes of flux while leather is made hard and unusuable by the combined action of flux and heat. Thick rubber or plastic gloves appear to give adequate heat protection and are extremely serviceable for hot-tinning work.

Tinning baths are of welded mild steel construction or, in some instances, of cast iron. The dimensions are such that there is ample room to immerse the largest article completely without approaching closer than 4 to 6 inches to the bottom of the bath. Automatic temperature control is advisable but not essential, but at least a clearly visible dial thermometer should be employed.

It is feasible to mechanize fully the hot-tinning of certain articles and a machine for the re-tinning of gas meter components has been described recently in the technical literature([8]). The meters awaiting reconditioning are dismantled with the aid of carefully placed gas burners to melt the soldered joints. The plates which compose the body are passed through a cleaning and fluxing station, and then into the bath of molten metal. Surplus tin is wiped off and the finished plates are ejected into a storage bin. The plant is completely automatic requiring one man to attend it. The rate of production of repaired meters is reputed to have been increased by a considerable factor by the installation of this machine.

Hot-tinning is often a stage in a more complex manufacturing process and an example is the pre-tinning of bearing shells prior to lining with a white-metal. Although steel bearing shells require little departure from normal hot-tinning practice, bushes manufactured from cast iron require special procedures.

Bearing shells are often manufactured from ordinary, engineering, grey cast iron and this is a material which has always presented difficulties to the hot-tinner. The difficulty arises from the presence of graphite flakes at the surface of the metal which cannot be removed by any normal pickling method. A number of different techniques have been devised in the past for overcoming the effect of this surface carbon. Generally speaking, either the surface of the cast iron is given a preliminary coating by electrodeposition, of a readily tinnable metal such as iron, copper or nickel, or alternatively the surface graphite is removed by more or less complex salt-bath treatments.

The graphite oxidation processes for treatment of cast iron are not usually employed for domestic articles, but may be particularly useful for bearing shells, since the tin enters the crevices from which carbon has been removed, giving a good bond between the whitemetal lining and the iron backing. The T.R.I. Fused Nitrate process([1]) and the Kolene process([9]), both employ a bath of fused salts suitably chosen for their oxidizing nature at temperatures of the order of 400° C and the latter process involves electrolytic treatment in such a bath. Although there are certain advantages to be gained by these methods, the procedure is somewhat complex and may not be suitable for the small jobbing tinner.

The Direct Chloride method ([10]), recently developed at the Tin Research Institute, is equally suitable for producing bright tin coatings, for protective and decorative uses, and for giving good adhesion in whitemetalled cast-iron bearings. The

articles to be treated are prepared by thorough shot-blasting using a fine, angular, chilled iron grit, of No. 70 mesh. Approximately 20-30 seconds blasting time is required on each square inch of surface, using this grit in a small, single jet cabinet. Alternatively, the rotary barrel type of unit, as shown in Fig. 6, may be employed successfully. It may be possible to obtain reasonably satisfactory results with coarser grits up to about No. 30, but longer times are generally required. The importance of using No. 70 grit is clearly illustrated by Fig. 7, in which two cast-iron mincer screws are seen, one treated with No. 16 grit and the other with No. 70 grit, only the latter resulting in a perfect coating.

Degreasing by trichlorethylene vapour follows, but in most instances the grit-blasting removes all surface grease and provided that any subsequent handling carefully avoids pick-up of grease, degreasing may be omitted. Any water-barrelling operations to improve the surface finish by burnishing may next be carried out. A typical barrelling unit, employing cast-iron balls is shown in Fig. 8. The tin bath, which should be maintained at a temperature of 300° C to 320° C, is covered with a flux blanket containing zinc, sodium and ammonium chlorides in the proportions of 73, 18 and 9 per cent. respectively, to a thickness of about 0·5 inch. The flux is thoroughly activated, prior to immersing the articles, by application of water as described earlier and shown in Fig. 4. In this process the flux becomes frothy and the layer may become 3 inches in thickness. The cast iron is pre-fluxed in the correct solution and is then lowered slowly through the ebullient flux into the tin (Figs. 9 and 10). Subsequent manipulation after tinning is as used normally. The use of a second palm oil covered tin bath at a lower temperature, *e.g.*, 250° C, is advantageous as any flux adhering to the surface of the casting is neutralized and removed by the oil.

One great advantage of the technique, is that since the flux layer contains a fair proportion of water, there is no tendency for it to crystallize and form a solid salt envelope on the cold iron; in effect the thick layer of ebullient flux serves to preheat the iron before entering the tin. The surface of the iron usually becomes tinned in about 30 seconds and for articles such as mincers, immersion times of a minute or two may be quite adequate to give the smoothest finish. For bearing shells the period in the tin bath should be about 20 minutes in order to ensure that any surface defects or blowholes in the iron have been filled with tin, the flux being dislodged in the process. Figs. 11 and 12 show groups of articles tinned by the Direct Chloride method.

Bond strength tests carried out on grey cast iron tinned by the Direct Chloride process and subsequently lined with a tin base Babbitt alloy, showed that the expected average value is about 2·25 to 2·50 tons per sq. in., while with spheroidal graphitic iron about 3·25 tons per sq. in. is obtained. These values are considered to be quite adequate for the majority of bearings of this type and it is believed that the uniformity of bonding is considerably better than is obtained by other methods.

Fig. 6.—A modern rotary shot-blasting plant in which several hundred mincer bodies or several thousand mincer screws may be treated at a time. (Courtesy Spong and Co. Ltd.)

It is interesting to note, that as an alternative to grit-blasting the relatively new technique of vapour-blasting[11] gives highly satisfactory results, the processing times being considerably shorter. One of the abrasives used in this process is fine

Fig. 7.—Effect of grit-size in Direct Chloride process for cast iron. Left-hand mincer screw treated with No. 70 grit giving satisfactory tinning; right-hand sample treated with No. 16 grit resulting in a completely dewetted coating.

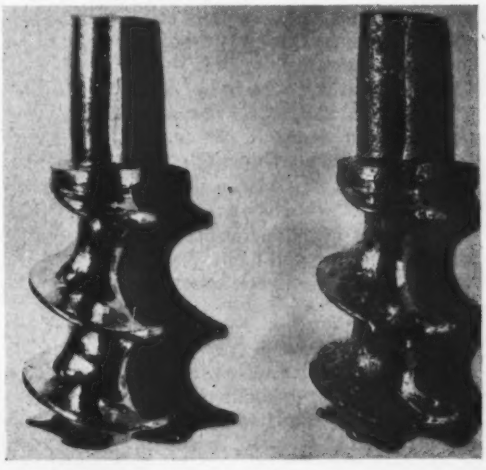


Fig. 8.—Burnishing of mincer bodies being carried out by rumbling for several hours with iron balls or stars in a water-filled barrel. (Courtesy Spong and Co. Ltd.)

alumina, carried in a fast-moving stream of water, which imparts to the surface of the iron a semi-bright finish. A pleasing, smooth and bright appearance results after hot-tinning, and hence, is particularly suitable for tinned domestic articles. The bond strength between whitemetal and cast iron processed by vapour blasting, is thought to be similar to that obtained with grit-blasting. It has also been found that a clean, grease-free ground surface on a grey cast iron is readily tinnable, without any subsequent shot-blasting.

The Direct Chloride method enables cast-iron to be tinned satisfactorily with very little trouble. By subsequent electroplating with a thin coating of a decorative metal, such as the tin-nickel alloy developed at the Institute[12], an attractive bright finish is obtained without any manual polishing, owing to the underlying bright tin coating. Cast iron, which has the advantages of being cheap and easy to machine, may thus become a material not only for engineering use, but also for applications where a good appearance is necessary, and the scope of this metal may thus be increased. A simple dipping process such as this may also be readily mechanized without undue difficulties.

After an article has been tinned by immersion, the molten coating has to be converted to a solid coating of reasonable uniformity and of about the required thickness and there are several alternatives for carrying out these operations.

Finishing Operations

It is usual to rely on the manual dexterity of the experienced tinner to obtain the necessary degree of finish on a hot-tinned article. Suitable machines may be devised to assist in such operations and improved uniformity of the product may be obtained.

To return to one of the most difficult articles to hot-tin, namely the milk transport can, it is necessary to drain off the coating in a hot oil bath or by other means until a sufficient but economic amount of tin remains. A new plant has been designed and built in Russia[13] for the finishing of milk cans by centrifuging and is a good example of the use of mechanical aids to hot-tinning. It is less difficult to centrifuge smaller articles and Fig. 13 shows a centrifuge in use for the finishing of shallow steel vessels. A few seconds spinning at 700-800 r.p.m. is usually adequate to obtain the required degree of finish. It is normal practice to heat the

Fig. 9.—A cast-iron mincer body being hot-tinned by the Direct-Chloride method at the Tin Research Institute. Note the vigorous boiling of the flux blanket promoted by water additions, as shown in Fig. 4.

centrifuge slightly with gas jets to help maintain the temperature of the tinned articles. After centrifuging it is usual to quench, preferably in paraffin, to maintain the brightness and uniformity of the coating.

When tags are dipped in bulk in a tin or solder bath they have to be centrifuged to remove excess metal. This is either carried out in the basket or they are tipped out of the basket into the rotating body of the centrifuge and spun for the required time. Subsequently, they have to be allowed to fall through a breaking device which prevents them sticking together before they are quenched in a tank of water. The breaking device in many cases consists of a fan, rotating at about 700 r.p.m. having flat wide blades set parallel to the axis of rotation. The tinned tags are allowed to fall into the blades, thus knocking off excess metal, and carrying them round until they fall off at the lowest point into the water quench.

During the tinning of ferrous articles the bath becomes contaminated with particles of tin-iron intermetallic compound (usually called "grit"). This may arise from two sources, first by the direct reaction between iron and molten tin and second, from the vigorous reaction between the iron entering the bath and the boiling flux layer. For good tinned coatings the proportion of grit present must be controlled at a low level.

Fig. 10.—A large cast-iron bearing shell being tinned by the Direct Chloride method. The smooth clean surface after fine shot-blasting is visible. (Courtesy G.E.C. Ltd.)

Maintenance of Tinning Baths

The removal of grit from the tin bath is generally carried out by poling with green wood or by blowing compressed air through the metal. In both cases the iron is brought to the surface and becomes attached to the dross which is floating there and can be readily skimmed off. An alternative method which has been used in tin refining processes is to filter the molten tin through a suitable medium, and this process has been patented[14]. However, it was found to be somewhat less efficient and suitable for this purpose than the poling method and as far as is known, is no longer used. Experiments are in

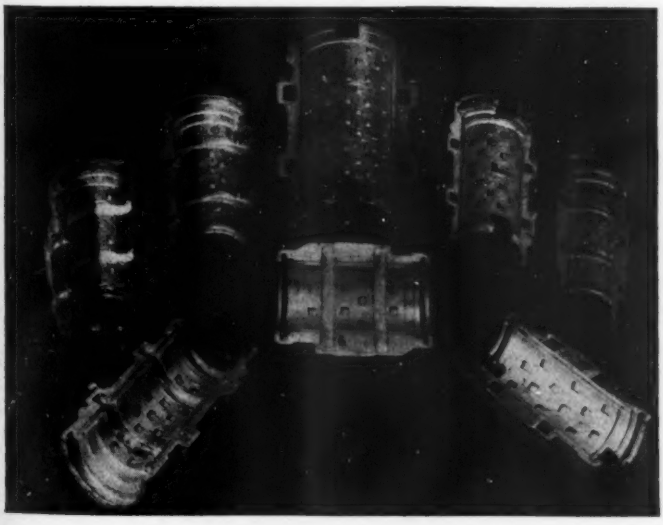


Fig. 11.—A group of bearing shells tinned by the Direct Chloride method. Adequate and uniform bonding of the whitemetal to the iron is obtained with these bearings. (Courtesy G.E.C. Ltd.)

Fig. 12.—Cast-iron mincer components tinned by the Direct Chloride method showing the satisfactory general appearance. Vapour-blasting in place of shot-blasting may give an even smoother finish.

progress in the laboratories of the Tin Research Institute with a simple, small-scale filter pump maintaining a steady flow of tin through a pad of material such as slag or glass wool, or similar substance. It is thought that such a machine might be used more or less continuously in the tin bath without interfering with the tinning production and might maintain the bath free of contamination.

A filtration procedure could also be employed for removal of tin-copper intermetallic compound from baths used for dipping copper-base materials. Since these particles of compound are considerably larger than those of tin-iron, there should be no difficulty in carrying out such a technique and present methods such as settling and skimming with a perforated ladle, or alternatively stirring in flowers of sulphur, may well be outmoded in the future.

The contamination of tinning baths by copper or zinc during the dipping of brass may also be prevented by coating the articles with a suitable barrier before tinning. Tags and similar small components for the radio and electrical industries may be dipped several thousand at a time in a wire basket, and the large surface area thus exposed normally causes rapid deterioration of the tin bath. In the light of work carried out in the past few years[15], the tags may now be electroplated with a flash of nickel before being tinned. The nickel acts as a barrier to the diffusion of copper or zinc into the molten tin. It is also reputed to prevent subsequent diffusion in the solid state which may cause poor solderability of such components after long storage.

Alternatives to Dip-Tinning

Electroplating to give a matt finish is generally less acceptable for domestic and similar uses than a hot-tinned finish although a known uniform thickness of tin may be readily applied.

An alternative which has been used successfully for many different types of both steel and brass articles combines the advantages of a bright, melted coating with a controlled thickness. The procedure consists of electroplating of tin followed by momentary melting (flow-brightening) of the coating. The electroplating should preferably be carried out in the sodium stannate tinplating bath and in the as-plated state the coating should be

(*Continued on page* 474)

Fig. 13.—A typical centrifuging operation showing the means of holding the article whilst it is rotated. Normally, the coating is subsequently solidified by quenching. (Courtesy Joseph Sankey and Sons Ltd.)

Methods of Protecting ALUMINIUM from Corrosion

A Review of Current Practice in the U.S.A.

by E. A. STOCKBOWER ★

A Paper presented at the 6th International Mechanical Engineering Congress, in Paris, June, 1956

Introduction

THE INDUSTRIAL use of aluminium is increasing at an unprecedented pace, and this most versatile metal is found today in almost every phase of manufacture in the U.S.A. Prior to 1940, relatively very little aluminium was made and used commercially in the U.S.A., with the annual production rate being about 150,000 tons. Even this represented an increase of three times the 1933 production of 50,000 tons. It is interesting to note that in 1933, about 1 lb. of aluminium was made for every 500 lb. of steel. Today the annual production rate is about 1½ million tons—a thirty-fold increase over 1933—representing a ratio of about 1 lb. of aluminium produced for every 70 lb. of steel. With the use of aluminium expanding into many fields, the problems of surface protection have increased, and coupled with this, the problems of handling relatively large-scale production arose in the manufacturing plants.

For this reason, chemical treatments for aluminium, which do not require applied current, have come into very wide use since the end of World War II. It is estimated that today in the U.S.A. considerably more aluminium is treated with non-electrolytic processes than with the electrolytic type, which had been used extensively prior to 1940.

The original non-electrolytic process was also used to some extent in the 1930's utilizing alkaline chromate and produced an oxide coating in a hot bath, requiring about 30 to 40 minutes to apply. Because of the long time required and the quality produced, this process had only limited use in the aluminium fabrication industry in the U.S.A.

In 1945, the American Chemical Paint Company introduced the Alodine 100 process, which produced an amorphous phosphate coating in a bath operated at 100° F in a 2- to 3-minute immersion time without requiring applied current. This development adapted itself so well to mass production and produced such excellent quality as a base for paint, that a great deal of impetus was added to the industrial move toward non-electrolytic type processes.

Since the development of the Alodine 100 type of coating, the recently developed amorphous chromate coatings have come into widespread use. Alodine 1200 is an excellent example of this type, and in about 2-minutes immersion time in a room temperature bath the coating is formed.

While both the amorphous phosphate coating and the amorphous chromate coating offer considerable protection to aluminium without subsequent paint, the amorphous chromate coating seems to have slightly better un-painted corrosion resistance in most cases. Both coatings also exhibit excellent paint bonding qualities, and increase paint life considerably. The amorphous phosphate coating and the amorphous chromate coating produce about equivalent quality paint-bonding purposes.

As a pre-paint coating only, the crystalline phosphate coating is often employed. This process requires from one to five minutes immersion time for coating at about 130° F and the coating thus formed is primarily comprised of tertiary zinc phosphate.

Today the anodic coatings are used in relatively few instances as paint-base coatings, but rather are used where un-painted corrosion resistance and high abrasion resistance are required simultaneously. Also, the anodic films are often dyed various colours for decorative purposes.

Some of the factors which have led industry to the change to non-electrolytic processes are:

A. Equivalent corrosion resistance and paint adherence.
B. The ability to process assemblies, which although primarily made of aluminium, may also contain dissimilar metal components (Amorphous-chromate type most flexible process in this respect).
C. Saving in special racking required for electrolytic process.
D. Saving in initial capital expenditure on equipment.
E. Saving in operating costs.
F. Saving in processing time.

The sulphuric-acid electrolytic process which offers the heaviest oxide coatings, is not used on any assemblies where the electrolyte may be entrapped, which can cause premature failures.

★ *Manager, Technical Standards Department, American Chemical Paint Co., Ambler, Pa.*

CHARACTERISTICS OF EACH TYPE OF COATING

Amorphous Phosphate

The following are typical characteristics of amorphous-phosphate coatings and coating process:

1. *Composition:* Amorphous aluminium and chromic phosphate.
2. *Colour:* Depending on alloy treated, colour range is from an iridescent blue-green to a dark slate-grey.
3. *Thickness:* From 0·01 to 0·08 mils. No appreciable dimension change occurs with the treatment.
4. *Weight:* 50 to 300 mg. per square foot. Optimum: 100 to 200 mg. per square foot of surface.
5. *Solubility:* Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis; however, strong acids and alkalis which attack aluminium may penetrate the film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate.
6. *Electrical resistance:* High dielectrical resistance.
7. *Heat stability:* Excellent. Coating unaffected by high temperatures.
8. *Flexibility:* Integral with and in most cases as flexible as the base metal. Can withstand moderate draws.
9. *Abrasion resistance:* About 80 per cent. of that provided by chromic-acid anodizing.
10. *Salt-spray resistance:* Painted: excellent—Unpainted: Fair to good.
11. *Paint bonding:* Excellent.
12. *Bimetallic corrosion resistance:* Shows good resistance to bimetallic or galvanic corrosion. Current requirements for coating: None.
13. *Typical Application Methods:* Brush on process (manual application). Immersion process—2-3 minutes at 110° F. Spray process—½ to ¾ minutes at 110° F.
14. *Number of chemicals required to operate bath:* Three.

Amorphous Chromate

The following are typical characteristics of amorphous chromate coatings and coating processes:

1. *Composition:* Amorphous, mixed metallic oxides and chromates.
2. *Colour:* Ranges from iridescent gold to light brown.
3. *Thickness:* From 0·005 to 0·01 mils. No appreciable change in over-all dimensions of work.
4. *Weight:* 35 to 80 mg. per square foot.
5. *Solubility:* Insoluble in alcohol, even water, solvents, gasoline and other petroleum products. Soluble in strong alkalis and acids.
6. *Electrical properties:* Surface is electrically conductive and can be shielded-arc welded.
7. *Heat stability:* Unaffected at moderate temperatures. Corrosion resistance lowered by long exposure to high temperatures above 200° F.
8. *Flexibility:* As flexible as the aluminium of which it is an integral part, thus making moderate drawing operations possible after the part has been coated and suitably painted.
9. *Abrasion, or Mechanical Resistance:* Slightly less abrasion resistant than anodic films.
10. *Salt-spray resistance:* Excellent.
11. *Paint-bonding:* Excellent.
12. *Bi-metallic (or galvanic) corrosion resistance:* Excellent.
13. *Adhesion:* Integral with the metal. Will not flake or peel.
14. *Impact resistance:* Excellent.
15. *Typical Application Methods:*
    Brush on process (manual application).
    Immersion process 1 to 3 minutes at 60 to 90° F (room temperature).
    Spray process ⅛ to ½ minute at 60 to 90° F (room temperature).
16. *Current requirements for coating:* None.
17. *Number of chemicals required to operate bath:* Two.

NOTE.—There is a relatively new process which has come into use during the past year called Alodine 1000, which produces a very light (less than 20 mg. per square foot) amorphous-chromate coating on aluminium, and which is quite similar to Alodine 1200 process outlined above, except that the process is operated hot, about 160° F, and the coating which is produced is essentially colourless. This coating is used as a paint base for clear organic coatings on aluminium.

Anodic Coatings Formed in Electrolytic Baths

The following are typical characteristics of oxide coatings processes:

1. *Composition:* Hydrated aluminium oxide.
2. *Colour:* Silver-grey to slate-grey (coatings can be dyed).
3. *Thickness:* 0·1 to 0·3 mils. (normally).
4. *Weight:* Chromic: about 200 mg. per sq. ft. Sulphuric: about 600 mg. per sq. ft.
5. *Solubility:* That of hydrated aluminium oxide.
6. *Electrical properties:* Very high dielectrical resistance.
7. *Flexibility:* Fair (heavier coatings poor).
8. *Abrasion resistance:* Sulphuric: Best of all chemical coatings. Chromic: Fair.
9. *Salt-spray resistance:* Sulphuric: Excellent. Chromic: Fair to good.
10. *Paint bonding:* Excellent.

11. *Bi-metallic corrosion resistance:* Excellent.
12. *Adhesion:* Fair to good. Integral with metal.
13. *Impact resistance:* Fair to good.
14. *Typical application methods:* Immersion method is applicable for both chromic and sulphuric anodizing.

CHROMIC-ACID METHOD:

1. Solution temperature: 90 to 95° F.
2. Minimum anode current density: 1 amp. per sq. ft.
3. Voltage: 38 to 42 volts.
4. Time of treatment: ½ to 1 hour.
5. Post anodic treatment: Hot water seal 150° F, minimum.

SULPHURIC-ACID METHOD:

1. Solution temperature: 68 to 72° F.
2. Average anode current density: 12 amp. per sq. ft.
3. Voltage: As required.
4. Time of treatment: ⅓ to 1 hr.
5. Post anodic treatment: potassium dichromate (5 per cent.) sealed at 212° F for 15 minutes, *p*H 5·0 to 6·0.

15. *Number of chemicals required to operate process:* One.

Crystalline-Phosphate Coatings

The following are typical characteristics of crystalline-phosphate coatings and coating process:

1. *Composition of coating:* Tertiary zinc phosphate.
2. *Colour:* Grey to dark grey.
3. *Thickness:* Less than 0·1 mil.
4. *Weight:* 150 to 300 mg. per square foot.
5. *Solubility:* That of zinc phosphate.
6. *Electrical properties:* High dielectrical resistance.
7. *Flexibility:* Fair.
8. *Abrasion resistance:* (Only used as paint base).
9. *Salt-spray resistance:* Good when used as pre-paint coating (not used for corrosion resistance without paint).
10. *Adhesion:* Good integral with metal.
11. *Impact resistance:* Fair.
12. *Typical Application Methods:*
    Immersion Process: 1 to 5 minutes at 130 to 135° F.
    Spray Process: ½ to 1 minute at 130 to 135° F.
13. *Number of chemicals required to operate bath:* Five.

SPECIFICATION REQUIREMENTS

The most active and prevalent specifications used in the U.S.A. require the following standards to be met by the various processes.

Oxide, amorphous chromate and amorphous phosphate coatings must withstand un-painted 20 per cent. salt-fog tests on 24-ST aluminium panels as follows:

Amorphous coatings	168 hours
Oxide	250 hours

There shall be no more than 10 per cent. reduction in elongation of the sample after the above exposure, when compared with unexposed blank. In addition, amorphous chromate and amorphous phosphate coatings must withstand 500 hours in 20 per cent. salt-fog when painted with a 2-coat paint system with no failure from scribe and no loss of general adhesion.

At the present time, new specifications are being prepared which will set various standards for the different categories and proprietary treatments of the non-electrolytic class of processes. This will be of great value, because some processes meet only barely the minimum specification requirements for certain tests while others consistently far exceed the minimum requirements of certain of the tests. Most specifications require quality control determinations be made at periodic intervals on the actual production line. Samples must be processed in every stage through which actual production would normally go. In this respect, specification requirements are quite realistic, for the overall quality depends not only upon the performance of one bath, but rather upon the entire sequence of operations.

The painted crystalline phosphate coating must withstand 150 hours of 20 per cent. salt-fog test with no more than ¼ in. failure from scribe. In this instance, the specified paint is 1·0 mil. of a specification-controlled air-dry lacquer.

PRE-TREATMENT CONSIDERATIONS

It is not the purpose of this paper to go into the many details of methods of removing soil from metallic surfaces. Suffice it to say that all oils, greases, waxes, drawing compounds, etc., must be removed prior to coating. Normally, alkaline silicates, suitable buffering and sequestering alkalis, and a balanced surface-active agent system will prove adequate, provided reasonable care is taken in the earlier stages of manufacture. It is interesting to note that most manufacturers in recent years have begun to realize the over-all savings possible by insisting that reasonable care and consideration be given to metal surface operations in the pre-finish stages.

All aluminium surfaces however, contain a certain amount of oxide which is insoluble in most normal exposure environments. It is most fortunate that this oxide exists and forms as rapidly as it does, for without it the metal known as aluminium might well have remained a laboratory curiosity.

From a finishing standpoint, if the oxide present on the surface is very unevenly distributed, or excessive, it must be removed before proper

coatings can be accomplished. The removal of this oxide can to a degree affect the quality of subsequent amorphous coatings. It is important that the least violent oxide removal treatment be employed which will cause removal of the heaviest oxide present. Phrased in another way, the less etch of basic aluminium caused by the oxide removal treatment prior to coating, the higher will be the quality of the subsequent coatings.

Oxide removal, including heat-treatment oxides, for most purposes can best be accomplished by utilizing a chrome-sulphuric-fluoride bath operated at room temperature. Those baths do not leave residue of "smut" even when treating copper-bearing or low-silicon-bearing alloys, and will also equalize differential surface conditions caused by work hardening, or cold-working, which condition often leads to non-uniform coatings.

For special purposes many proprietary materials are available which remove oxide at controllable etching rates, and in some cases brighten; these materials in many instances have considerable merit.

Strong alkalis, such as caustic soda, are normally used only to produce a "matt" or "satin" finish, and normally are used only when the aluminium surface thus produced will affect the appearance of the final decorative finish. Since high metal loss is associated with this treatment, most specification requirements and aircraft producers will not employ strong alkali-etch materials because of the potential danger of weakening structural parts or entrapment of solution.

A typical process sequence which should serve to meet most production requirements would be as follows:

1. Alkaline cleaning (inhibited), grease and oil removal.
2. Water rinse.
3. Oxide removal } if necessary.
4. Water rinse }
5. Chemical coating.
6. Water rinse.
7. Acidulated final rise.

It is to be noted, that in stage 3 above, "oxide removal", the minimum attack on base metal should be allowed for optimum quality results, as mentioned previously.

EQUIPMENT CONSIDERATIONS

While most chemical treatments for aluminium today are carried out in immersion processes, utilizing conventional tanks as used in plating, etc., it is of interest to note that industry is rapidly changing over to the power-spray technique for the application of all chemical treatments other than anodizing, which must be carried out by immersion methods. While maintenance requirements of the power-spray units in the production plants are somewhat greater than for the immersion tanks because of pumps, nozzles, etc., the increase in production afforded greatly over-shadows the maintenance aspect.

A great deal of interest and industrial expansion is now going into power-spray "strip" lines, whereby strips of aluminium, from 3 in. to 4 ft. in width, travelling from 100 to 150 feet per minute, are cleaned and chemically coated by spray application, dried and roll-painted on the same line. The chemically treated and painted strip is then formed into the item being produced. Venetian blinds, awnings, siding panels for homes, screening, signs, are a few of the items manufactured in this fashion.

Concerning the over-all problem of a manufacturer purchasing equipment for the application of chemical treatments to metal, there is one basic point which would seem to be obvious, but often is overlooked. When considering the installation of a process for chemical treatment of metals, the potential purchaser of equipment should first contact a reputable chemical supplier, preferably with long experience in the field, to establish the equipment needs for the production problem and the proper process sequence, taking into account at least the following:

(*a*) The type of metal being treated.
(*b*) The ultimate use of coating.
(*c*) The case history of the metal item.
(*d*) The plant space available.
(*e*) The over-all operating cost allowable for operation.
(*f*) The initial capital expense allowable for equipment.
(*g*) Future possible production requirements, *i.e.*, mixed metals, change of models, etc.
(*h*) The present and planned production rate.

When the above basic considerations have been decided upon, the equipment manufacturers should then be consulted to bid competitively on the equipment needs as decided by the purchaser and the chemical process supplier. Quite often an excellent chemical treatment or process has been forced to produce only marginal-quality results because the basic equipment available has been marginal or of poor basic design, or planning has been inadequate.

Most chemical suppliers with long years of experience in the field recognize this problem and have developed capable engineering staffs available to offer fundamental engineering drawings upon which equipment manufacturers can base their bids. These drawings can in no way replace the experience and reliability of reputable equipment suppliers, but they can establish basic process cycles and prevent equipment suppliers with limited experience from offering marginal equipment at marginal prices.

Coatings for High-Temperature Service

NOW AVAILABLE IN U.K.

Details of Flame-Sprayed Refractory Coatings with Some Notes on American Experience

REQUIREMENTS for structural materials to withstand ever-increasing temperatures always have been, and will continue to be, a problem for designers in many fields. This was particularly true with the advent of the jet and rocket engines, where stability of the structural materials under high temperatures and often great extremes of thermal shock has a major bearing on the efficiency of the unit. Rocket propulsion gases may have a temperature exceeding that of white-hot molten steel, and with any metal combustion chamber and venturi, it is not surprising that severe erosion takes place during firing, often with premature destruction of the unit. For example, a steel rocket venturi with a throat diameter of approximately 4 in. can increase ½ in. in diameter in 10 seconds firing through a combination of melting and erosion by the high velocity hot gases. Until recently the only answer has been to provide sufficient metal to permit this wear or to attempt artificial cooling, both of which methods add a considerable amount of unwanted mass.

Norton Company of Worcester, Mass., U.S.A., instituted a research programme to investigate possible new materials and processes for high temperature operation, with particular reference to rockets, and one outstanding result of this programme was the discovery of the method of applying protective coatings of high melting point pure oxides, spinels and other materials to metal, graphite and other surfaces. This has resulted in the development of the "Rokide" Coating Process★.

Ceramic protective coatings are not new and a number are available which are very effective at temperatures under 1000° C. These are usually enamel compositions and applied by spraying the powdered pre-formed enamel on to a cleaned metal surface, then melting the enamel by placing the coated part in a furnace. The use of such coatings may be limited for three main reasons:—

(1) The enamel must have a melting point lower than that of the surface to which it is applied and imposes this limitation on the operating temperature.
(2) The base material may be detrimentally affected by the enamel furnacing operation.
(3) There may be limitations as to size or design which could be handled in furnacing.

Rokide coatings are claimed to have few limitations in application. The process is carried out on the cold base material and even an oxide such as zirconia with a melting point of *ca.* 2500° C can be satisfactorily coated on to the lower melting point metals such as aluminium and magnesium. The temperature reached by the article during coating is unlikely to be detrimental and coatings have actually been applied to certain synthetic resin materials without visible charring. The coating thickness can be controlled quite closely and, if necessary, it can be varied for particular locations on an article. In addition to metals, other materials which can be coated satisfactorily are solid carbon in various forms, glass, ceramics and asbestos compositions, in fact, no inorganic constructional materials have yet been submitted which could not be coated. The only limitations as to size which could be visualized, lie in the lower limit—it is not practicable at present to coat the inside of tubes or holes less than 3 in. diameter if the length exceeds four times the diameter and, of course, accessibility to a spray gun is a necessary requirement.

Although it is possible to use a wide variety of coating materials, experience has shown that requirements are likely to be suited by one of three materials which have, therefore, been adopted as standards. These are Rokide "A" (Alumina), Rokide "Z" (Zirconia) and Rokide "ZS" (Zircon), the properties of which are given in Table I.

Table II shows the principal properties compared with a stainless steel.

The coating operation itself is simple and an unskilled operator can be trained in a few days. The coating materials are in rod form and a pistol type oxy-acetylene flame-spray gun specially designed for the process is used. The rod is fed at

★ This process is the subject of British Patent No. 745,257 of August 7, 1953 (Published February 22, 1956).

TABLE I—*Properties of Rokide Coatings*

	ROKIDE A	ROKIDE Z	ROKIDE ZS
Chemical Composition, per cent.	98·6 Al_2O_3	98 Lime Stab. ZrO_2	65 ZrO_2 34 SiO_2
Crystal Form	Gamma-type	Cubic ZrO_2	Cubic ZrO_2 Silica Glass
Bulk Density, gm. per c.c.	3·2	5·2	3·8
True Density	3·6	5·7	4·15
Total Porosity	8 to 12	8 to 12	8 to 12
Thermal Exp., per °F between 70 and 2550° F	$4·3x10^{-6}$	$6·4x10^{-6}$	$2·3x10^{-6}$
Thermal Cond.	19	8	15
Total Emissivity	·3—·4	·3—·4	·3—·4
Melting Point, °F	3600	4500	Glassy phase at about 3000
Colour	White	Tan	Tan

a constant rate through a central hole in the burning nozzle, which is surrounded by a cap suitably spaced to pass compressed air. The rod becomes molten in the luminous white cone of the burning gas and small particles are projected off at high velocity by the air blast, striking the surface to be coated while still in a plastic condition. At the same time, the passage of the air over the burning nozzle prevents the equipment from overheating. If it is required to coat long internal diameters, special extension nozzles can be used of the desired length. The rod is fed between two opposing drive rollers which are driven by a constant speed electric motor through a variable reduction gear. The thickness of coating possible does not appear to be limited and coatings of 2·5 mm. thickness have been applied. The rate of coating varies according to the material used and for a coating 0·010 in. thick may at the present time be from 70-150 square inches an hour; for example, alumina is near the top figure while zirconia is very much slower.

Thicker coatings, of course, require proportionately longer time.

To promote adhesion, which is largely mechanical, a metal base being coated is first prepared by roughening with a shot-blasting operation and with correct surface preparation the coatings are remarkably tenacious. Uniform quality and strength is maintained throughout the whole depth of coating, and, because the process requires that each particle must be molten before it can be transmitted to the coating surface, duplication of the highest possible quality is ensured. It is not possible for the coating to be weakened by the incorporation of unfused or partially fused material.

Although the process was primarily developed for thermal protection, the character of the coatings is such that a much wider field of application is provided. For example, the hardness of Rokide "A" (Alumina) is comparable with that of the alumina used in grinding wheels and it can therefore be used to provide a wear resistant surface on metals and other materials. The coatings themselves are unaffected by most chemical agents and stable in combustion atmospheres. The electrical insulation property of the coatings is high through a wide range of temperature. With these properties, either alone or in combination, it is apparent that there is a great potential future for the process in many fields.

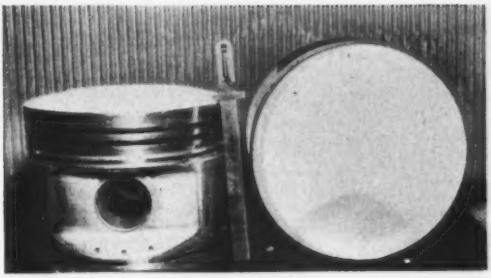
The measurable properties have been given in Tables I and II, but some of the general characteristics are discussed further. The nature of the process is such that molten droplets of the coating material freeze on to the surface of the metal and on each other to form an interlocking layer structure of low porosity and this layering effect apparently increases the flexibility of a normally rigid brittle material. A thin sheet coated with Rokide can be bent and flexed to a remarkable degree without breaking or cracking the coating. Furthermore, in addition to this mechanical flexibility, the ability of the coating to adjust to stresses also results in a very high resistance to thermal shock. A localized

TABLE II (*right*)—*Comparative Properties of Oxides and Stainless Steel*

	Aluminium Oxide	Zircon	Stabilized Zirconium Oxide	Stainless Steel
Thermal Expansion per ° F from 70 to 2550°F	4·3 $x10^{-6}$	2·3 $x10^{-6}$	6·4 $x10^{-6}$	12·2 $x10^{-6}$
Thermal Conductivity (BTU/hr./sq. ft./in./°F) mean temp. of 1500°F	19	15	8	185
Density, gm. per c.c.	3·2	3·8	5	7·8
Melting Point, °F	3600	3000	4500	2600
Hardness, Knoop	2000	1000	750	400

(*a*) (above) *Cast-iron pyrometer tube coated with Rokide "A".*

(*b*) (right) *Aluminium-alloy piston heads coated with Rokide "A".*



impingement of a flame at about 5000° F on a 0·010-in. thick coating for two or three seconds can be sufficient to melt the coating but, on cooling, although the fluidized surface may show fine cooling stress cracks, the adjacent coating and underneath the molten surface is still intact. In a further test, the metal base was removed from a piece of coating 1 mm. thick and 2 cm. square. This was heated in a furnace to approximately 1100° C and immediately dropped into cold water with no apparent detrimental effect. Although the coatings appear to be the complete answer to many thermal, corrosion, erosion and electrical problems, there are possible limitations associated with their slight porosity. In some cases, with a long enough time, corrosive agents will permeate through the coatings and attack the base material although such attack will be much slower than for uncoated material. Under thermal cyclic corrosive condition it is possible that reaction products may form on the base metal underneath the coating and, in time, these can inhibit the movement of the coating with the base and repeated thermal expansion may then cause loosening. This possible effect is mainly associated with convex surfaces such as the outside diameters of tubes and sharp edges and, related to this, it should be kept in mind that, after all, ceramics are brittle materials with compressive strengths about 10 times greater than their tensile strengths and tensile stresses on the coatings due to thermal expansion are likely to be more severe on such convex surfaces. This feature is receiving active attention and already very considerable improvements have been effected. The process is still young and refinements to enable the outstanding properties of the coatings to be fully utilized are continually being evaluated.

Interest in the possibilities of ceramic coatings has been principally centred in the aircraft industry, and in the U.S.A., both the Ryan and Solar companies made use of such materials more than a year ago. However, until now in the U.S.A., most aircraft manufacturers have apparently obtained the best high-temperature results from high-barium alkali-free frit materials of the type developed by the U.S. National Bureau of Standards.

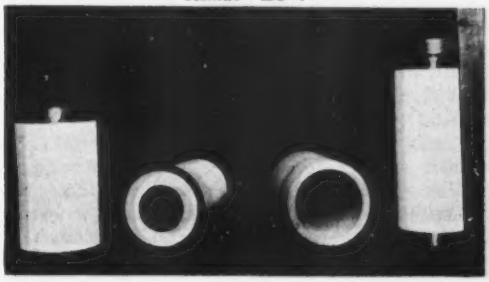
It is now reported that the Marquardt Aircraft Co. of Van Nuys, California, has been making specific use of Norton's Rokide "A" material; and according to Alan V. Levy, the company's supervisor of materials and processes, it has been evaluated in terms of the following properties:

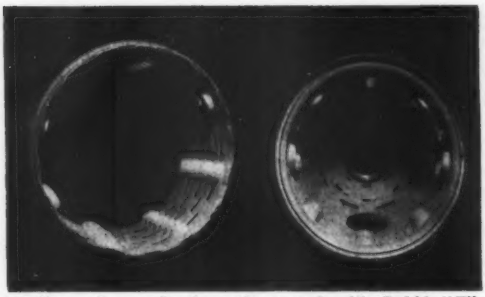
(1) Ability to withstand temperatures in the 2000° to 2500° F range.
(2) Applicational characteristics which permit the use of coatings thick enough to produce thermal lags and crops of several hundred degrees.
(3) Lightness required to prevent restricted usage due to weight penalties.
(4) Resistance to severe mechanical vibrations and elastic deformations of base metal for time intervals up to one hour.
(5) Capability of being cycled several times.
(6) Deposition qualities which will maintain the smoothness of contoured surfaces.
(7) Low porosity, such as is required to prevent oxidation due to the ability of flames to reach base metal.
(8) Low emissivity coefficient.
(9) High fuel and moisture resistance.
(10) Ability to resist chipping due to normal handling stresses.
(11) Availability and usability from the economic viewpoint.

Levy adds that the evaluation proceeded through three stages—which involved use of the alumina material on (1) flat plates, (2) small-diameter cylinders subjected to combustion gases, and (3) full-scale engine components.

The objective was to determine the practicability of using the coatings on combustion chamber and

(*c*) *Bearings and rings coated with Rokide "A" and Rokide "ZS".*





(d) Jet-engine combustion tube coated with Rokide "Z".

flame-holder surfaces. Of these, the combustion chamber represents the most severe application.

In preliminary evaluation work, small panels of alumina-finished stainless steel were satisfactorily torch-tested; and then a series of 3-in. diameter, 4-in. high cylinders were internally sprayed with the ceramic material. The cylinders were tested by passing hot gases due to propane-air combustion through them at temperatures up to 3600° F with a mass flow of 530 lb. of fuel and air per hour. Thereafter, it was found that both 0·020- and 0·050-in. thick coatings were unaffected by temperatures up to 2500° F for heating intervals of an hour each; and that no metal protected by the coatings was oxidized.

Further, it was determined that the thermal drop through the coatings to the base metal was appreciable in each instance. At equilibrium conditions, attained after about seven minutes of operation, the following temperatures were recorded:

Cylinder with 0·020-in. coating	
Inside wall temperature (corrected)	2510° F
Outside wall temperature ...	2270° F
Thermal drop, Total	240° F
Thermal drop per 0·001-in. of coating	12° F
Cylinder with 0·050-in. coating	
Inside wall temperature (corrected)	2550° F
Outside wall temperature ...	2150° F
Thermal drop, Total	400° F
Thermal drop per 0·001 in. of coating	8° F

In work with full-scale engine components that followed, 0·030-in. thick coatings were utilized on ramjet combustion chambers or tailpipes and on V-type gutters of ramjet flameholders; and several parts were finished only in areas where heating conditions were most severe in order to determine the protection that was being obtained by subsequently comparing coated and uncoated surfaces.

Results then noted after operational tests were most favourable, although coatings on gutter components failed to perform as well as those on combustion chambers. Severe engine vibrations failed to loosen the ceramic-metal bonds in the combustion chambers, and the only flaws observed after repeated operations were the result of local hot spot buckles which might have been avoided if the parts had been properly processed.

In the flameholder coatings, cracks developed quickly in the edges; and after two or three runs, the finishes were completely removed. It is believed that this sort of thing can be prevented in the future by re-designing the flameholders so that they will have no sharp edges to be finished.

Comparisons of partly coated components disclosed marked differences, despite engine performance limitations. Combustion chamber surfaces which were uncoated, for example, failed in less than 15 seconds; and adjacent surfaces which were coated remained intact as long as the tests continued, even though they were exposed to higher temperatures. Some oxidation took place in the metal beneath the latter coatings, but that was to be expected in view of the fact that the combustion chambers were not completely finished.

Mechanical tests made with the subject coatings revealed remarkable resistance to impact, and in many cases neither ceramic nor metal materials were damaged by repeated blows made with the ball end of a ball peen hammer.

Metallographic investigations indicated that the metal-ceramic bonds produced in applying the coatings were primarily mechanical, since there were virtually no signs of intermetallics or inward coating diffusion.

Rolling tests made with coated tailpipe sections on a set of 8-in. rolls, showed that the ceramic finishes could be cold rolled to a 7-in. radius (starting from a radius of 14 in.) without cracking and spalling.

Rokide coatings are now being tested for their suitability in a wide range of applications in the U.K. as well as America. They have already provided a solution to a number of difficult problems of which details cannot be disclosed, but consideration of their remarkable thermal, electrical and wear-resisting properties as indicated in Tables I and II, together with the fact that they are capable of being ground to precision tolerances, would indicate that they have a promising future.

The patent in Great Britain is owned by Norton Grinding Wheel Co. Ltd., Bridge Road East, Welwyn Garden City, Herts., who are now carrying out the process and, in cases of successfully developed uses of the process, are prepared to grant user licences under the patent and supply the spray unit and coating rods. Metallisation Ltd., of Dudley, Worcs., manufacture the special spray units necessary and are collaborating in the further developments of the process in this country. Metallisation Ltd. will also supply spray units and rods, and licences will be granted to users recommended by them.

CEBELCOR COMMENTARY

Scientific Activities

DURING recent months CEBELCOR has pursued its scientific activities in the study of the electrochemical behaviour of metals and metalloids as well as in fundamental studies on corrosion. Reports have been published and circulated on the electrochemical behaviour of molybdenum (RT.35) and of magnesium (RT.39).

The technical commission on cathodic protection (CT.4) has decided to admit new members desirous of taking part in its work and to grant them access to all the results obtained from its previous works. The present research programme of the Commission is primarily concerned with the cathodic protection of steel and lead structures or components which are either buried or immersed; also being studied is the behaviour of reactive anodes in zinc and magnesium. It is envisaged that application studies will be carried out relating to the cathodic protection of lead-covered cable, concrete reinforcing metal and ships' hulls.

The Commission has authorized the publication of an important report on the behaviour of reactive anodes of magnesium and zinc (RT.34).

Technical Activities

The Centre continues to be called in for consultation on numerous occasions by widely varying branches of industry. Mons. Laureys, the Centre's engineer, has made a second stay of two months in the Congo in order to supervise, under the auspices of the Corrosion Service of the Belgian Industrial Association, the work of protecting from corrosion the high-pressure conduits of the Congo power station.

Conferences, Courses and Meetings

During the summer period, the conferences organized by the Centre were suspended, although activities under this head were continued by the active participation of members of the Centre at other meetings in Belgium and abroad, notably;

May 2—4 The meeting on "Equipment for the Petroleum Industry", organized at Liege by the Belgian Committee of Constructors of Petroleum Equipment.

May 3—5 First Belgian Congress on "Packaging" under the auspices of the Belgian Institute of Packaging.

★ *This report follows an earlier note describing the activities of CEBELCOR* (METAL FINISHING JOURNAL, 2. 20, *August*, 1956, *page* 282-284)

*A Report of the Activities of the Belgian Corrosion Research Centre**

May 7—9 International meeting for "The Study of Waters" held at Leige under the auspices of the Belgian Centre for the Study of Documentation of Waters.

May 31—*June* 2 Conference on "Corrosion and the Protection of Materials", organized at Zagreb by the Yugoslav Society for the Protection of Materials.

Sept. 8—16 Fifteenth International Congress on "Pure and Applied Chemistry" at Lisbon.

Sept. 17—23 The Eighth meeting of CITCE (Comitè International de Thermodynamique et de Cinetique Electrochemiques) at Madrid. This meeting was attended by 67 representatives of 16 countries, who presented 59 papers of which 13 emanated from CEBELCOR. Two new study commissions were set up dealing with electrochemical kinetics and with the electrochemistry of semi-conductors.

The proceedings of this meeting are to be published shortly by Butterworth and Co. Ltd. The ninth meeting will be held in Paris in July, 1957. This will comprise in particular a Symposium on "Modern Electrochemical Methods of Analysis" under the auspices of the Physical Chemistry Section of which CITCE has since 1955, been an affiliated commission, and of Analytical Chemistry Section of the International Union of Pure and Applied Chemistry.

Oct. 11—12 Meeting of the Supply Water Section of the Vereinigung der Frosskesselbesitzer at Aix la Chapelle.

Oct. 15—19 Seventy-Third Colloquium of the National Centre of Scientific Research organized at Paris by Mons. E. Darmois, on the theme "Reference Electrodes and the Constitution of the Double Layer".

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CHEMICAL BLACKENING LINE ADAPTED TO BARRELLING

Significant economies achieved by re-design of a coating line in U.S. works

A SCHEME for improving the materials handling and processing in a black-oxide coating line for steel products has recently been carried out by the Colson Corporation, Ohio, U.S.A.

In the previous set-up, articles for chemical blackening were loaded into baskets and transferred from tank to tank until the process was completed. This involved the danger of products masking each other so that the blackening solution could not reach all the surface, thus necessitating repeating the treatment. It was also possible for salts to accumulate in folds and recesses, causing subsequent corrosion.

It was decided to investigate the possibility of installing a barrel line similar to that used in plating. Since the barrel had to resist hot caustic-soda solution, steel plate, instead of the plastic barrels generally used in plating, were needed. It was found that a barrel suitable for the purpose was not being made and the company therefore designed its own.

The main features of black-oxide coatings on steel are the pleasing black colour, the excellent adhesion, and the degree of corrosion resistance obtained, especially when treated with a rust-inhibiting oil or wax.

The salts required for producing a black-oxide coating on steel consist usually of a mixture of caustic soda, sodium nitrite and sodium nitrate. Cyanide can also be used as a reducing agent to prevent the formation of red oxide and to keep the solution in operating condition for a longer time.

An important factor to ensure the production of material of uniform high-quality is the proper control of temperatures in the two tanks containing the blackening salts. The solutions should preferably be kept automatically at pre-set temperatures and the addition of the salts or water regulated so that the solution will boil at those temperatures. This can be controlled by a bulk-type temperature-indicating controller operating a motorized valve in the water line through a relay. As the solution

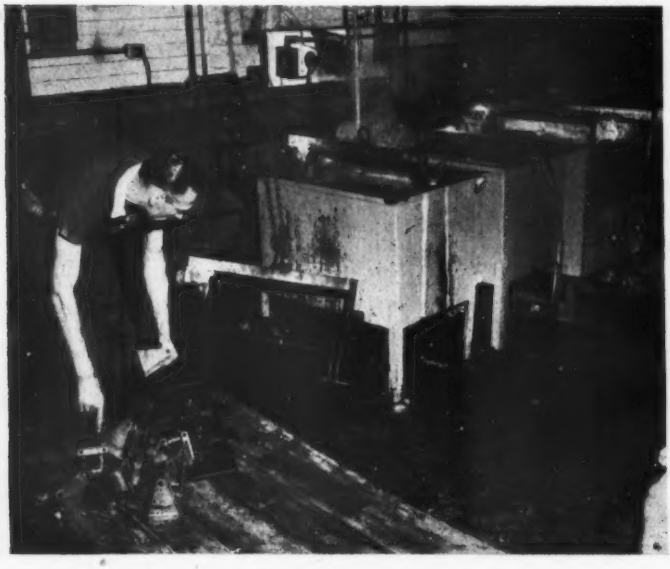

Fig. 1.—Entry end of chemical blackening line showing cleaning, rinsing and pre-treatment tanks through which work is processed in fully submerged mild-steel barrels. One of these barrels is shown in front of the line being loaded with parts for processing.

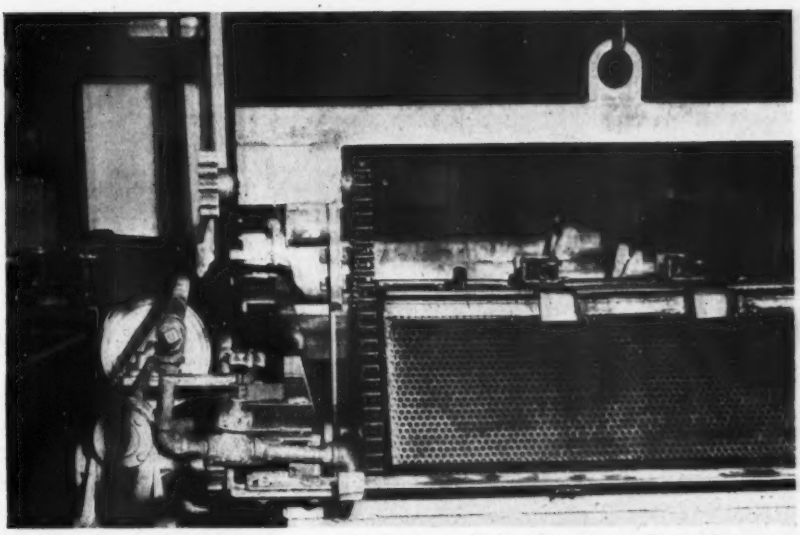

Fig. 2.—Barrel load of parts for blackening shown entering the cleaning tank. The chain drive to the barrel and the spur gear which engages with the drive motor can be seen on the left of the illustration.

evaporates and becomes more concentrated, the boiling point rises above the control temperature and a signal from the controller causes the motorized valve to open, allowing water to enter. When sufficient water has been added, the controller closes the valve. When the water level gets below a certain height, salts are added and the automatic controller comes into action until the level of the solution is normal.

The process of forming a black-oxide coating consists of thoroughly cleaning the work, preferably using a two-tank system with different concentrations of blackening salts at two different automatically controlled temperatures, and finishing with a rust-inhibiting coating.

The design of barrel adopted by the company is approximately 2 ft. 3⅜ in. in length and 1 ft. 3 in. between the sides of the hexagon, with a volume of 3·1 cu. ft. Both ends of the barrel are enclosed by a ½-in. thick hexagon cut plate at one end and a 1-in. hexagon cut plate at the other; the thicker plate is used to give sufficient weight to balance the driving units at the other end of the barrel. Stub shafts supporting the barrel at both ends project sufficiently to fit smoothly into the channel guides welded to the tank. The barrel is hung by heavy steel hanger brackets at both ends; a projection of tubing acts as a lug to engage the channel guide and aligns the barrel in the guide.

A steel rod is welded at both ends of these hanger brackets to help the barrel ride in the channel guides. A large sprocket bolted to the barrel is driven by a sprocket chain connected to a small drive sprocket which is connected with a spur gear by means of a steel shaft which rides on a bronze sleeve bearing. The drive unit is set to rotate the barrel at 2½ r.p.m.; at this speed excellent coverage is obtained.

On closely analyzing the company's requirements, it was decided that six steel unlined tanks, measuring 2×2×3 ft. and with a capacity of 12 cu. ft., and five barrels, would ensure continuous operation.

As shown in Fig. 1, the work is placed in the open barrel, seven-eighths of which is filled. An electric chain hoist picks up the barrel and transfers it to the cleaner tank. When contact is made through the spur gears, the barrel begins to rotate. The cleaner is operated at a concentration of 2 oz. per gallon at a temperature of 180° F. Heating is by steam passed through coils at the side of the tank. The cleaning operation is shown in Fig. 2.

After 10 minutes the barrel is picked up by the hoist and transferred to a hot-water rinse tank kept at a temperature of 160° F. After being rotated for five minutes it is transferred to pre-treating blackening solution, which is kept at a concentration of about 7½ lb. per gallon and at a temperature of 290° F for 10 minutes. During this period the work receives excellent coverage throughout. The barrel is then transferred for 10 minutes to the main blackening tank which is kept at a concentration of about 10 lb. per gallon at 305° F.

The rotation of the material produces a uniform black and salts do not concentrate in the folds and recesses. After being transferred to a cold-water rinse for a few minutes, the barrel is finally immersed in rust-inhibiting solution for two to three minutes. The cover of the barrel is then removed and the material dumped into a handling unit for delivery to the next station.

Three great advantages have been derived from using this barrel line:

The basket operation required two shifts five days

(*Continued in page* 472)

COATINGS FROM SEA WATER

Extensive Claims for a Remarkable Process

A NEW electronic coating process now being developed, by the Electric Fish Screen Company, Los Angeles, U.S.A., promises to eliminate two of the oldest and most expensive enemies of seagoing vessels—namely, corrosion and barnacles. In addition, it may prove to be a practical method of extracting mineral wealth from sea water—the largest source of raw materials that remains untapped in the world today.

It consists briefly of using high-voltage, low-frequency current to ionize or polarize particles suspended in water so that they become attracted to a grounded metal deposition surface, such as the hull of a ship.

Although they comprise both metals and non-metals, the particles adhere well to steel surfaces eventually becoming uniform greyish coatings.

Finishes of optimum thickness are obtained in about 48 hours, after which metal surfaces are apparently insulated to such an extent that no further deposition can take place.

Measurements to date indicate that the coatings have maximum depths of less than 0·005 in.—the thickness of a standard electroplated coating. This should not be a serious disadvantage, since the new finishes have excellent abrasion resistance and could be replaced at frequent intervals for only a fraction of the annual cost of normal hull maintenance work. In fact, naval authorities have expressed the belief that the ultra-thin coatings will have an important advantage, because they cannot make a material contribution to the weight of a ship.

Extensive tests have shown that the finishes not only inhibit corrosion, but prevent the growth of algae and other minute forms of marine life which provide nourishment for barnacles.

Due to its probable value to the U.S. Navy, the test coating equipment cannot be described in detail at present. However, it can be said that its main operational distinction is its ability to produce relatively high-voltage pulses.

The pulsed output is delivered *via* a Monel pipe electrode which may be submerged several feet away from the deposition surface in each instance, and since brine is an excellent current conductor, the power consumed in the process is said to be less than 100 Watts.

Fig. 1.—Mr. H. T. Burkey, who has developed the new coating process, holds in his upper hand a steel test specimen that has been treated by the new process. In his lower hand he holds an identical specimen which has not been finished. Both specimens have been subjected to six-months' immersion in sea water; the lower specimen is covered with a thick coating of rust and minute forms of marine life; the stains on the upper specimen are harmless water marks.

Specimens being finished at present are 12-in. x 15-in. x $\frac{1}{8}$-in. steel plates. Considerably larger surfaces comprising many different metals could be satisfactorily coated with existing test facilities, but more elaborate equipment would probably be required for most practical purposes, such as the hull of an aircraft carrier in the course of a long sea voyage.

In addition to protecting the hulls of seagoing vessels, the new coatings could be used to prevent the deterioration of oil-well equipment, pilings, intake tunnels for utility plant cooling systems, and many other structures which are exposed continuously to salt water. In fact, some manufacturers in coastal areas may eventually employ salt water as extensively as they now utilize plating solutions for finishing purposes!

If used in conjunction with a distillation process to recover valuable minerals, the equipment may also help to eradicate the economic barrier that

(*Continued in page* 472)

PORTABLE STEAM-SPRAY RIG REDUCES COATING TROUBLES

in an American Plant

Fig. 1 (above).—*Made-to-measure dolly enables one man to push steam-spray equipment to any job where it may be needed.*

Fig. 2 (left).—*Steam-spray gun in use at Douglas Aircraft works to lacquer inner surfaces of a major assembly.*

A DOLLY-MOUNTED "airless" spray rig is saving time and minimizing coating defects on the finishing of assemblies, which due to their large size, have to be processed outside of the paint shop, at the works of the Douglas Aircraft Co., Santa Monica, Calif.

Previously, large assemblies were finished with regular pneumatic spray equipment, but this was not entirely satisfactory for two reasons:

(1) Overspray during finishing operations created a serious fire hazard.

(2) Applied coatings frequently acquired orange-peel defects.

Airless or steam-spray equipment has been available for several years, but due in part to the fact that initial facilities of this type used steam from relatively large boilers, it was, until recently financially impractical for most companies to provide all the accessories required for steam spray work, particularly in plants extending over a large area.

In addition, older steam-spray units lacked the controls essential for the application of thermo-plastic materials commonly employed in aircraft work. Because of this, airframe manufacturers in general have not enjoyed the advantages others have gained in using the steam-spraying technique.

Following the recent development of airless equipment with internal atomization facilities and improved hydraulic controls, Douglas engineers

(*Continued in page* 472)

Portable Steam-spray Rig

(*Continued from page* 471)

reviewed the steam-finishing method, and it was realized that the new airless units were sufficiently compact to be employed on a portable basis, and also that steam spraying should eliminate the objectionable features of pneumatic finishing, where coatings had to be applied outside the spray booths. Consequently, airless equipment was obtained and mounted on a specially designed "dolly".

The dolly is a 2½-ft. × 4½-ft. steel-plate structure mounted on rubber-tyred castors so that the steam-finishing equipment can be pushed by one man to any plant area where coatings must be applied.

Cost of the entire set-up was about $3,000, or slightly less than the cost of a comparable pneumatic spray rig, and it is currently being used by one specialized finisher on each of three daily shifts in the Douglas plant. The finishers needed about eight hours of instruction and practice before they were allowed to take over steam-spray work.

The overspray produced in using the new equipment is negligible and cannot be regarded as a serious fire hazard, because steam-sprayed particles lack the aerosol properties that facilitate combustion. Simultaneously, orange-peel has been eliminated because steam-heated coating materials have no tendency to solidify before they are uniformly incorporated in a given finish.

Because overspray is being minimized, the company is probably saving substantial quantities of lacquer in using airless equipment. However, no effort has yet been made to determine the extent of such savings.

Work records showing the amount of time devoted to each finishing operation revealed that labour savings averaging about 33⅓ per cent. were obtained with the airless equipment and these would probably be higher still if the new equipment did not require careful adjustment prior to each new job; this is because a stream-sprayed coating can be built up to such a thickness in one pass that it will serve the purpose of an air-sprayed finish which must be applied with two or more passes.

Apart from the fact that it needs careful regulation, the only feature of airless equipment that might be considered a disadvantage is the need for more cleaning time than must be expended on pneumatic spray equipment. Although at the present time this can be regarded as a minor item, it may produce maintenance problems which have not yet had a chance to develop.

No operational modifications have yet been made in the company's initial steam-spray unit at Santa Monica, but a second set-up of the same type in the company's El Segundo (Calif.) plant is reported to be undergoing a series of changes in its basic design.

Official comment on the latter project is not available, but it has been stated unofficially that the objective is to permit the heat vapourization of finishing materials in such a way that spraying can be effected without pressure from either pneumatic or steam sources. In this connexion, a number of important questions remain to be answered, but results already obtained have been sufficient to arouse much enthusiasm among finishing test personnel.

Coatings from Seawater

(*Continued from page* 470)

retards the commercial purification of sea water.

"Deep sea mining" potentialities of the equipment remain to be investigated. However, due to the differing magnetic and electrical properties of materials, it is at least theoretically possible to collect ionized particles in solution on plates carrying varying electrical or magnetic charges so that little or no supplemental processing will be needed to make use of the collected materials.

For example, gold might be collected on one plate; silver, on another, and after a suitable quantity of either element is accumulated, a chemically pure material could be obtained simply by scraping the appropriate collector plate.

The development of the subject equipment is the indirect result of many years of work with "fish fences" which are now being used throughout the world to keep fish, etc. from entering municipal reservoirs, hydroelectric water lines, and other facilities where they might cause serious mechanical damage as well as pollution.

Chemical Blackening Line

(*Continued from page* 469)

a week to complete all blackening, in comparison to two 8-hour shifts with the barrel line. Whereas there was a bottleneck with the previous method, an excess capacity is now available.

The material has been so uniformly treated that it has been possible to eliminate the inspection station.

The cost of the operation has been reduced substantially. Percentage savings on the following parts are: top plate, 54 per cent.; axle sleeve, 45 per cent.; outer race, 58 per cent.; fork, 58 per cent.; and outer race, 66 per cent.

By redesigning the materials handling equipment in the blackening operation it has thus been found possible to reduce cost, upgrade the quality of the coating, and substantially increase the capacity of the blackening line.

This installation is noteworthy in that the bulk finishing by chemical processing of components in barrels is still comparatively novel, although its application in electroplating has been common practice for some time.

FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . . .

Advice on all aspects of metal finishing practice is offered on these pages, and while every care is taken to ensure the accuracy of information supplied no responsibility can be accepted for any loss which may arise in respect of any errors or omissions.

Power Supplies for Plating Plant

Dear Sir,

In reply to the comments by your contributor "Platelayer" on my claims for the efficiency of motor generators as manufactured in the United States for plating power supplies I would make the following points:

I believe the fact can be readily established that low-voltage d.c. rotating machinery as manufactured in this country for electrolytic operations is exceedingly conservative as compared with other types of higher voltage d.c. machines manufactured here, and considerably more conservative than the standard low-voltage machine produced in Britain or on the Continent.

This does not mean to indicate that the British-made motor-generator set would be inferior, as their experience would certainly be competent to design and manufacture similar equipment. However, user preference has established these design principles, primarily dictated by the automotive industry where historically the need for electroplating power has fluctuated with the annual change in designs of cars. This trend has always in the past been in a direction to require more power and the heavy overload capacity of the American design has been of sufficient benefit to justify the higher inherent cost.

As a matter of simple comparison a standard 10,000-ampère, 6-volt motor-generator set complete in an all-welded steel design would weigh in excess of 12,000 lb. operating at the very conservative speed of 360 r.p.m.

In regard to the duty cycle I do believe that it is more severe because of periodic rapid expansion of product output which has necessitated frequent long periods of operating at heavy overloads on three-shift duty.

Your correspondent makes the statement by inference that the comments in my earlier letter indicated that "future prospects will further favour the use of rectifiers as against generators". My statement was merely to the effect that there was a trend towards germanium- and silicon-type rectifiers rapidly superseding the selenium.

I wish to assure you and your readers that there are parallel developments being made in rotating machinery to increase efficiency and other operating improvements as well as reducing costs which can very well place the rotating-type power unit in an increasingly favourable competitive position with even the latest type of rectifiers.

The statement is further made by your correspondent that "firstc-lass maintenance is necessary if high efficiencies are to be consistently obtained". Historically I know of no product which has had a more favourable record of continuous and dependable operation under the most severe operating conditions with little or no maintenance than these low-voltage motor-generator sets. This statement would be strongly endorsed by thousands of operators who have had continuous experience as long as 25 to 30 years with small and large installations of this equipment, and of various makes.

Any statements in regard to maintenance on the rectifiers actually becomes highly controversial because of the many different makes and styles, but you can be well assured that any poll of these same operators having dual experience in operating motor-generator sets and rectifiers would heartily endorse the statement that they have had far less maintenance requirements on the rotating machines.

Yours very truly,

GORDON J. BERRY.

President,
The Electric Products Company,
1725 Clarkstone Road,
Cleveland 12, Ohio.

Directors and Dustmen

Dear Sir,

In the November issue of METAL FINISHING JOURNAL "Platelayer" argues that "in the last analysis pay is determined by supply and demand" —but I would suggest that this statement does not agree with the facts.

If it were true coal miners would be receiving fantastic salaries, for owing to the excess of demand over supply it has been found necessary to bring foreign labour to the rescue.

Just imagine the Ministry offering "directorships" (fares paid) to our Continental neighbours!

"Platelayer" has not even weighed the specimens, let alone completed the "last analysis". I can think of a better one than that.

Yours faithfully,

E. F. CROSSWELL.

Cippenham,
Bucks.

Developments in Hot-Tinning

(*Continued from page* 458)

white and not greyish in appearance. The coating must not exceed 0·0003 in. in thickness. Thorough rinsing after plating is essential, and after drying the surface should not be handled before flow-brightening, which should follow without more than a few hours' delay.

The oil bath is maintained at 270°C.±5°C. and the time of immersion of the electro-tinned articles should be the minimum required to fuse the coating completely. The articles may be subsequently air-cooled or quenched in paraffin, the latter medium also serving to remove some of the oil. Final traces are dissolved by solvent or vapour degreasing. Success has been obtained when using ordinary heavy lubricating oils, but it is recommended that slight acidity in the oil (neutralization value about 5 mg. KOH per gm. of oil) is an advantage. Thin oxide films on the tin are then dissolved, ensuring a bright surface. Such an oil may be made up by mixing about 9 volumes of Shell "Vitrea 79" with 1 volume of Shell "Peblum" tinning oil.

The acidity of this oil may decrease in use and is maintained by occasional small additions of the "Peblum" oil. When the oil becomes too dark and viscous for convenient use it should be discarded. Tallow or palm oil are possible alternatives, but should be heated for some time before use to reduce the acidity to the required level. Other proprietary oils are being examined in the laboratories of the Institute for their suitability for this technique.

The finish is applicable to coatings on brass, copper and steel, but it is preferred to electro-deposit on the latter an undercoat of about 0·0001 in. of copper or red bronze before tinning. Red bronze containing 10 per cent. tin normally gives the most satisfactory result. Before plating, the basis metal must, in all cases, be thoroughly degreased cathodically, and acid dipped for a slightly longer time than normally employed. If bulk plating and flow-brightening of small components is practised, a mechanism of the type described earlier must be used to separate the articles before quenching.

The process gives a smooth, bright finish of good solderability and the latter property is maintained during long storage periods. Generally the procedure is considered as a useful alternative to hot-dipping in cases where articles are of small size or of complicated shape; and in cases where dimensional tolerances are such that rather thin and very uniform coatings are required.

It is hoped that this paper will form a useful supplement to the booklet "Hot-Tinning" and shows that several important advances have been made in the past few years and progress is steadily continuing at the present time.

The author is indebted to his Directors and to the International Tin Research Council for permission to publish this paper.

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CEBELCOR Commentary

(*Continued from page* 467)

Publications

The following publications have recently been issued by or in collaboration with the Centre.

Memoranda and Articles of General Interest.

"The Protection of Steel Against Corrosion by Metallic Coatings with Particular Reference to Hot-Dip Galvanizing" by J. F. H. van Eijnsbergen. Technical Report No. 36 of CEBELCOR and review of the Royal Belgian Society of Engineers and Industrialists No. 9/10, 1956. "Protection Against Corrosion in Packaging and During Storage" by F. Vandervelden and M. Pourbaix. Technical Report No. 37 of CEBELCOR and "Proceedings of the first Belgian Congress on Packaging." "Services That Corrosion Research Centres can Render to the Petroleum Industry" by M. Pourbaix. Technical Report No. 38 of CEBELCOR and "Proceedings of the Conference on Equipment for the Petroleum Industry" published by the Belgian Committee of Constructors of Petroleum Equipment.

International Activities

Members of the Centre were invited to participate in the majority of the International functions referred to above; it was particularly gratifying that they were able to take part as guests at the meeting of CITCE held in Madrid in September. This is symptomatic of the trend whereby CEBELCOR, which since the beginning of 1955, has been open to bodies of other than Belgian origin in order to promote friendly collaboration, is now experiencing considerable development outside Belgium. It is thus acquiring at the present time the nature of an International technical and scientific body of which more than a quarter of its members are non-Belgian, representing seven other countries in Europe as well as Australia and the United States of America.

Some Aspects of VITREOUS ENAMELLING PRACTICE in AUSTRALIA

by A. R. WILLIAMS

SINCE the end of World War II, the population of Australia has increased by more than one and a quarter million people.

To cope with this very great influx of people, industry has had to expand very rapidly, particularly those industries connected with housing and accommodation. It is in this field that the vitreous-enamelling industry has played a very important role. Naturally more homes meant more gas, electric and fuel stoves, coppers and boilers, etc., and these commodities meant more enamelling.

Top management soon had plans for the rapid expansion of the industry, and today the picture is very different from that which was presented a half century ago.

The first enamelling furnace in Australia was built at Melbourne in 1896, and it was here that the early baths and sinks were enamelled. In 1898 Adelaide had its first furnace for the enamelling of sheet iron and kitchen ware, and Sydney commenced enamelling sheet iron in 1908. Two years later, production of enamelled baths and sinks was started, and in 1912 Melbourne commenced to enamel sheet-iron ware.

During the early days, a story of long struggle could be told, concerning cargoes that were delayed, furnace difficulties caused by faulty fire bricks, and oversights in ordering materials from other countries. Poor quality materials were received from overseas, and the labour available was totally unskilled. However, from 1930 onwards a rapid change took place; labour became more skilled, material specifications were adhered to, and furnace requirements became more readily available. After 1945 the accent was on mechanized and continuous plants, and the benefits of these plants are today being enjoyed by many firms.

At present there are six continuous furnaces, and seventy-five box-type furnaces operating in all Australian states. Of the continuous furnaces, five are electrically fired "U" type, and one is a seven-burner "U" type, oil-fired. The box-type furnaces are either electric or oil-fired, the electric type predominating.

The forty firms engaged in enamelling, have plants ranging from fully mechanized types, to small plants which in some instances cannot boast a dryer, so the approach to the industry is varied.

Most of the firms are producing stock lines, such as panels for gas and electric stoves, also fuel cooking and heating stoves; refrigerator interiors; kitchen holloware; baths, basins and sinks; washing-machine tubs; light reflectors; table tops; and many other items of cast iron and sheet iron, which require not only a protective coating, but also lustre and colour.

Generally, all these commodities, with the exception of baths, basins and sinks, are made of sheet iron or steel, which has replaced cast iron wherever possible in stove manufacture. Recently one-piece pressed-steel baths were successfully put on the production line, and these have been marketed satisfactorily in Australia. However, cast iron is the favoured material for the major production of baths, basins, sinks and other sanitary ware items.

Naturally, with such a variety of items to process, enamelling supervisors have become very control minded. In the past, control procedures were haphazard and in some cases non-existent, but with the advent of increased production, together with very necessary costing control, pickle rooms, mill rooms, spray and dipping lines, also raw materials, are now generally found to be under very strict control.

The following are typical control methods found in use throughout the industry:—

IRON AND STEEL

Due to shortage of high-grade enamelling iron, in many cases poorer grades have to be used. A typical case is the use of a black iron with a carbon content as high as 0·12 per cent. To control any variations, checks are constantly carried out to determine the enamelling character-

istics of these metals. The results of these tests allow any alteration from standard procedure to be adopted. In most cases, it has been found that by altering frit blends, mill additions and firing techniques, these inferior grades of iron and steel can be successfully enamelled.

CLEANING

Accepted methods of pickle-shop cleaning are used, *viz.*, alkaline cleaner, hot sulphuric acid, nickel dip and soda borax neutralizers. These solutions are kept under constant daily, and sometimes hourly, chemical control. The trend of late however, has been to replace the soda borax bath with sodium-cyanide neutralizer. It has been found that this solution when incorporated with nickel dip, gives a greater removal of ferrous iron salts, thus reducing copperheading tendencies.

These procedures are generally adopted by the larger plants, but many smaller jobbing plants still greasefire and anneal their work because of various irons and steels used, and the different types of drawing and forming compounds used in fabrication.

MILLING

Generally, milling controls are the same as adopted overseas, emphasis being placed on accurate weighing of materials, cleanliness and correct interpretation of specifications.

Prior to unloading from mills, all enamels are checked for fineness and specific gravity, and before used in production, fired samples are taken to ensure correct standards.

Rotary sieves and magnetic separators are gradually becoming standard pieces of mill-room equipment.

APPLICATION

For various reasons, application methods vary, but in the main, controls are as follows:—

(*a*) *Ground Coat*

Wherever possible, dipping or draining practices are employed, particularly where continuous production is involved.

Application weights range between $1\frac{1}{2}$-$1\frac{3}{4}$ oz. per sq. ft., the objective being to maintain a fired ground-coat thickness of between 4 and 5 thousandths of an inch. This is generally achieved by working enamel with a specific gravity of between 1·64 and 1·66.

(*b*) *Cover Coat*

Practically all cover-coat enamels are sprayed, the exception being enamel for kitchen holloware which is usually applied by swilling. Most of the enamels used are titanium acid-resisting types, and are sprayed at a specific gravity between 1·72 and 1·74, with a coating thickness of 3 to 4 thousandths of an inch. Thickness reading tests are carried out regularly in order to hold the total thickness below 15 thousandths of an inch, which is considered the maximum safety limit.

Frit making is not commonly practised in Australia, most firms purchasing their requirements from manufacturers who specialize not only in frits, but in general ceramic raw materials.

An important development in enamels has been the introduction of self-coloured frits. Colour matching has been difficult to maintain with most titanium enamels, and any discrepancies in materials, application and firing, etc., have given some very off-standard colours. Self-coloured titanium frits are the answer to this problem, and because of their uniformity and colour stability, are becoming very popular. Their colour range at the moment is confined to creams, buff, green and blue, but with constant research taking place, other colours will soon be placed in the "self-coloured" category.

Quite a number of raw materials used in the manufacture of enamels are of local origin, but it is necessary to import a certain percentage of materials. The following are materials produced in Australia:—

Silica, Fluorspar, Titanium, Rutile, Soda Ash, Feldspar, Zinc Oxide, Zircon Sand, Cobalt, Antimony Oxide, Copper Oxide, Tin Oxide.

For the benefit of overseas readers who may wish to compare the production of their own countries with that of Australia, the following are some production figures for the year 1953/1954.

Baths	...	...	75,000
Fuel Cooking Stoves	...		48,000
Gas Cooking Stoves	...		40,000
Electric Cooking Stoves	...		30,000
Domestic Refrigerators	...		237,000
Washing Machines	...		150,000

These figures are by no means the maximum annual requirements, and production is still taking place at an increased tempo, to cope with the ever-increasing demand.

I have been asked to refer in particular to some of our Australian problems, but on checking these, find that most countries have similar difficulties. However, a condition that has given enamellers in Australia a lot of trouble, is a surface defect that occurs when using titanium enamels.

One of the difficulties encountered in the use of titanium enamels is a pitting condition, together with uneven surface patches. After numerous experiments, sulphur contamination was found to be the root of the trouble. This sulphur contamination did not manifest itself as a scum, but acted as a flux, creating uneven roughened surfaces, and large depressions. This action was found to be primarily an absorption action of the gas into the bisque cover coat, which, combined

with the high proportion of alkaline salts in titanium enamels, formed sodium sulphate, which acts as a flux.

This problem has been encountered in a number of plants in Australia, and the following details will enable readers to follow the procedure in tracing this condition in one of our large plants. This plant has oil-fired furnaces, and gas- and oil-fired dryers.

Tests

Tests were run at various locations in plant to determine whether:—

(i) SO_3 content of atmosphere;
(ii) Sulphate content of plant dust

were within limits acceptable for successful operation of titanium enamels.

Conclusions

(i) Atmosphere determinations show SO_3 concentration of 12-15 p.p.m. (Acceptable limit is 3 p.p.m.)
(ii) Dust determinations showed sodium sulphate contents of 0·6—1·9 per cent. (Sulphate content of plant dust should be nil.)
(iii) Contamination of bisque cover coats by absorption of sulphurous gases and by sulphur-laden dust, are undoubtedly the causes of the pitting and uneven surface conditions experienced with titanium frits.
(iv) Sulphur-laden dust in the plant can only be removed by thorough clean-up of equipment and roof girders. Its re-formation can only be prevented by eliminating discharge of all sulphur-bearing combustion products from gas and oil-fired Dryers into an unventilated plant atmosphere. Natural ventilation relied on in some cases cannot prevent build-up of sulphur gases in plant atmosphere.
(v) Mechanical ventilation which removes combustion products to outside atmosphere as they are discharged from the dryers, would keep sulphur content of plant atmosphere to acceptable limits.

Discussion

Procedure:—

(i) Atmosphere determinations were run as follows:—

30-40 cu. ft. samples were aspirated through alkaline solutions at a rate of 5 cu. ft. per hour. SO_3 of plant atmosphere, fixed as sulphate by alkaline absorption solutions, was determined turbidometrically as barium sulphate.

Samples were taken from:—

(i) Flatware bisque cover coat drying and storage area opposite a box furnace.
(ii) Vicinity of oil-fired holloware dryer.
(iii) Mouth of continuous furnace.

Dust analyses were run as follows:—

Samples of dust—about 60 gm.—were collected in a vacuum cleaner; 50 gm. of the dust were digested with nitric acid, and sulphate present was determined gravimetrically as barium sulphate.

Samples were taken from:—

(i) Swilling booths near dryer.
(ii) Flatware bisque and storage area.
(iii) Continuous furnace area.

The results are displayed in Table I.

Discussion of Results

Atmosphere samples are well outside permissible maximum of 3 p.p.m. SO_3.

Samples 1 and 2 at 12·4 and 15 p.p.m. SO_3 are indicative of the general atmosphere condition in the plant.

Sample from mouth of continuous furnace is lower at 6·25 p.p.m. SO_3; this lower reading is due to good ventilation.

Sodium-sulphate figures of 0·6 and 1·9 per cent. in plant dust are very high. These concentrations have serious effects on titanium enamels.

Atmosphere and dust sulphur figures in the vicinity of oil-fired dryer are high, due to:—

(i) Bad contamination of the atmosphere by SO_2 and SO_3 formed as combustion products of sulphur-bearing fuel oil.
(ii) Reaction of this highly acid atmosphere with alkaline enamel dust forming sul-

TABLE I

ATMOSPHERE ANALYSES

	Volume cu. ft.	Location	SO_3 Content, p.p.m.	Permissible Max., p.p.m.
1	30	Flatware bisque storage section opposite furnace	12·4	3
2	40	Vicinity oil-fired dryer.	15	3
3	40	Mouth of continuous furnace	6·25	3

DUST ANALYSES

			Sodium Sulphate content, per cent.	
1		Storage area near continuous furnace	0·6	Nil
2		Storage area near continuous furnace	0·6	Nil

phates, which are deposited throughout plant.

It must be remembered that oil and gas fuels both contain sulphur. SO_2 and SO_3 will be formed in the products of combustion, and when discharged from dryers will be carried into the plant atmosphere. These gases are very harmful to titanium enamels, and if not removed as quickly as formed they will:—

(i) Build up dangerous concentrations in the whole plant atmosphere.
(ii) Form pit-producing sulphate-laden dust with enamel dust particles present in the atmosphere.
(iii) Be absorbed by the highly porous bisque cover coat, forming the sulphates which on firing, flux vigorously, giving characteristic uneven surface.

Combustion products because of their sulphur content, must be vented to outside atmosphere. They must not be allowed to circulate in the plant atmosphere, coming in contact with bisque cover coat and contaminating plant dust.

Needless to say, action has been taken at this plant to eliminate the cause of this trouble.

Another problem that has caused many headaches in Australia, has been the problem of hard water. So bad and so damaging has been this condition, that plants have been known to be temporarily closed down until the position eased.

In relation to hardness, Melbourne's water position is very consistent, while Sydney and Perth vary slightly, but both Brisbane and Adelaide supplies are highly variable, and it is in these two cities that enamelling troubles are found due to water condition.

The troubles mainly encountered are copperheading and blisterings, with copperheading more prevalent. In some cases pieces of fired ground coat are affected in small areas, yet in other pieces the entire panels are covered with copperheads of even pattern.

The real source of the trouble is found in the pickle room, and the following information gives the reasons for this condition.

CLEANER SOLUTION

Hard waters and waters of high mineral concentration form insoluble soaps in the solution, and thus use up some of the soaps that should be available for efficient cleaning. Since in many cleaning compounds resin soaps are used, the insoluble soaps formed with hard waters consist of calcium and magnesium compounds of resin. These materials are sticky and viscous, and drag out on the ware leaving the cleaner tank, and are difficult to rinse completely. If all of these materials are not removed from the pores and surfaces of the sheet iron, they may be acted upon by the acid of the pickling tank to form free acid compounds of the original soaps, which are resinous in nature, and which prevent complete and proper pickling of the metal. These materials may carry through on the work to the ground-coat dipping tank, where breaks may show up in the enamel as it is being drained. If such dirt caused by metallic soaps in the cleaner tank is apparently covered up in the dipping operation, it may still appear on the fired ware as copperheads and burned-off spots.

RINSING SOLUTION

If the water in the rinse tanks is hard, the dissolved salts will react with the cleaner solution carried over by the ware from the cleaner tank, to form insoluble metallic soaps. Such soaps are not free rinsing, and will result in a curdy, slimy condition in the rinse tank in proportion to the hardness of the water. This contamination in the rinse water may drag out on the ware, and cause enamelling defects.

PICKLING SOLUTION

It is possible in sections where high concentrations of lime salts are found in the water, to develop a suspension of calcium sulphate in the sulphuric acid solution due to the high concentration of the common sulphate ion, and the concentration of the lime salts due to evaporation losses of the acid tank. In such cases, this calcium-sulphate suspension may drag out on the ware, and cause enamelling defects in the form of blisters or sometimes copperheads in the ground coat.

NEUTRALIZER

The neutralizer compound contains alkalis, often-times soda ash being the main ingredient. Such weak alkalis have a softening effect on the water, and if hard water is used for the neutralizer solution, some of the neutralizer compound is consumed in softening the water, before any of it becomes available to act as a neutralizer. In hard waters, slimy, curdy precipitates form on the addition of neutralizer compound, and such precipitates may drag out on the ware, and cause the same troubles as contamination from the cleaner-tank solutions.

The solution to this problem has been the use of water softeners, the "Zeolite" type being generally favoured. The use of rain water and distilled water has been used, but storage difficulties are usually encountered with this system.

Naturally the industry in Australia is faced with some opposition from other trades who can supply competitive finishes, competitive possibly in appearance, but certainly not in durability,

(*Continued in page* 482)

An Account of DE-ENAMELLING PRACTICE in a French Works

by M. CAMUSET*

EVER since enamelling plants have operated on an industrial basis, de-enamelling has always been a matter of concern for enamellers. Regardless of the method employed, either by sandblasting or chemical solution, the question of enamel recovery has been very much discussed during the past few years.

De-enamelling by sandblasting removes the enamel completely. Unfortunately this method if employed for the de-enamelling of sheet metal will tend to distort the metal and it may often be difficult to use it again. In the case of thick sheet metal this disadvantage is almost completely eliminated; however, no matter how thick the sheet metal may be, de-enamelling by sandblasting will erode the surface of the metal which will become uneven and therefore it will be more difficult to obtain a perfect enamel finish. In addition to these technical disadvantages, the cost of operating such a plant is high and it is often a more expensive process than manufacturing new parts.

De-enamelling by immersion in acid has been almost completely abandoned. When the parts are immersed in acid the enamel will be removed within a few hours. As the coat of enamel covering sheet metal is generally not of even thickness on the entire surface, certain places will be stripped before others and thus rapidly corroded by the acid. After the enamel has been removed the sheet metal will be noticeably thinner. In the case of sheet metal which has remained in acid for a long period of time, subsequent enamelling will be more difficult. The cost of operating a de-enamelling plant by the acid method is high and the use of this method is extremely dangerous.

De-enamelling by immersion in caustic-soda solution gives good results and its use is widespread. This operation consists of filling up a steel tank with 50 per cent. caustic-soda solution which is heated to a temperature of approximately 120° C. Once this temperature has been reached the parts to be de-enamelled are placed in a tray and immersed in the solution. This tray is usually raised and lowered in the solution by means of an electric hoist. In most plants the tray is lowered into the de-enamelling tank by a frame, suspended a few inches from the bottom of the tank. This frame is also part of a mechanism called an agitator which moves the tray back and forth and agitates the solution on the parts to be de-enamelled, thus rendering the de-enamelling by the solution more effective. After a period of 6 to 12 hours, depending upon the thickness and type of enamel covering the components, the de-enamelling operation proper is completed. The tray containing the parts is then taken out of the tank and the parts removed and washed.

A solution that is being used for the first time or a replenished solution, must be carefully watched while the temperature is rising. At the time the tank is filled, the proportions of caustic soda and water are not always accurate and there is a risk of the solution overflowing. If the solution boils and overflows this indicates that the concentration or caustic soda is insufficient and it will then be necessary to add more. A water supply will have to be provided in order to compensate for loss by evaporation.

Several methods are used for heating the tank for de-enamelling by the solution method, the two most commonly used being heating by electrical resistors immersed directly into the solution and heating by town gas by means of burners of the "Bunsen" type placed under the tank and protected from water splash and overflow of the solution.

The performance of the solution is mainly dependent upon the work that is required from it. If it is utilized extensively, after two or three weeks the solution will be considerably less effective and it will be necessary to replenish it by allowing the solution to settle for two or three hours in order that the sludge can collect at the bottom of the tank. Once the sludge has settled all the solution that is considered suitable for re-use is transferred to another tank. After this is done, all the sludge

* S.O.D.I.

accumulated at the bottom of the tank is removed. Certain plants incorporate a sludge tray which facilitates this operation.

After the tank has been cleaned the caustic soda which had previously been considered good for re-use is transferred back into the tank and water and new soda is added to the solution which can then be used again.

The de-enamelled parts are freed from the caustic soda by rinsing in running water, and then by washing by hand. This operation is lengthy because, in the case of de-enamelling by the solution method, it is normal for some enamel to remain slightly stuck to the parts. Vigorous scrubbing of the de-enamelled parts by means of metallic brushes is necessary, and there is a possibility that the parts will be scratched and damaged. This method requires rudimentary equipment and the results obtained with regard to production are often disappointing due to the lengthy de-enamelling process, the difficulty of washing of the parts and the number of personnel employed. These facts raise the cost considerably.

De-enamelling by the molten caustic process requires a steel tank filled solely with pure caustic soda. The temperature is then raised to approximately 500° C. As the temperature increases, the volume of the caustic decreases, therefore, it is necessary to add more until the desired level is obtained.

The components are then immersed in the fused caustic soda and after two or three minutes, they are withdrawn from the tank, stripped of all enamel and, after washing, they are ready for re-enamelling.

Description of De-enamelling Plant at S.O.D.I.

The tank employed is made of 15-mm. thick steel, completely electrically welded. It is rectangular, 1·20 metres long and 1·10 metres wide; it has a usable depth of 1·20 metres. The lower part of this tank is diamond shaped. The tank is positioned above a wide pit by means of two U-shaped iron supports welded on the front and rear sides. The tank is surrounded by a thin sheet-metal outer casing 15 cm. distant from the exterior surface of the tank proper. This space is filled with heat insulation, which in this case is "vermiculite". On the lower section of the tank, there is a system of sliding tubes for emptying the tank.

Inside and at the bottom of the tank, a space has been provided for the sludge tray. Protective sheathing is placed above the tank to guard against splashing of caustic soda when the components are immersed. This sheathing is insulated and is equipped with two doors operated by automatic remote control. These doors are used to let the load of components in and out of the sheathing. The doors are always closed at the time the load of components is lifted above the tank, and remain closed until the load is removed from the tank.

A hood is placed above the tank for discharge to the outside of the building of the fumes produced by the caustic; this is done by natural draught.

The tank is heated by infra-red by means of radiant tubes immersed directly in the caustic. Each tube is fed with town gas by means of individual burners, each tube being separately controlled. An exhaust for the products of combustion is provided, and in order to obtain better results, the exhaust stack is provided with induced draught and equipped with a small ventilator. This system of tubes permits the caustic to "freeze" without the risk of having the tank burst by expansion of the caustic when the heat is again applied to the tank. Further, as the tubes are the only parts that wear out in a relatively short time (they have to be replaced approximately every four months), a device has been provided for removing the worn tube and for replacing it with a new one within a few minutes.

The temperature of the caustic is regulated by a thermocouple control connected to a pyrometer. This device is connected to a valve, equipped with a by-pass which automatically turns down the gas to the pilot flame. The pilot flame is adjusted so that the gas supplied will correspond to a constant temperature of 500° C.

The components are immersed in the tank by means of a rack which consists of a thick vertical tube equipped with six horizontal arms which are terminated by a U-shaped iron. The ends of this iron are equipped with pulleys, used for the passage of the cable supporting the tray. At the other end of the cable is fastened a pneumatic jack which itself is fastened to a support which is welded to the central tube. Six identical jacks corresponding to the six arms of the rack are operated by remote control from a pneumatic valve controlling the compressed air. These jacks are utilized for the lifting and lowering of the trays containing the components. A hot-water tank, heated by fuel oil, is installed on the circuit of the rack and a natural-draught fume hood is installed over the hot-water tank.

The operator places the components to be de-enamelled in the tray which is to be immersed in the de-enamelling tank. When this tray is in the "down" position, it is called the "loading station".

After loading the components, the operator then depresses the valve handle controlling compressed air, thus permitting the lifting of the six trays to the "up" position. The operator now steps on the pedal located near his loading station.

This pedal controls the opening and closing of the two doors on the sides of the protective sheathing. He lets the rack move 1/6 of a turn and the load of tray No. 3 is thus introduced within the protection sheathing placed above the de-enamelling tank. He steps again on the control pedal to close the doors. Then he depresses the valve handle to lower the trays.

At this moment, tray No. 1 is at the loading-unloading station, tray No. 4 is in the de-enamelling tank, tray No. 5 is cooling off, and tray No. 6 is in the hot-water tank, where the de-enamelled parts are first rinsed off and where most of the caustic is removed. Stations No. 2 and No. 3 are provided to balance off the load supported by the rack and to facilitate the arrangement of the other stations. Components unloaded at station No. 1 are then introduced into water tanks where they remain until the next day, when they are washed off.

In order to obtain improved results when re-enamelling it is practice to let the parts remain in water for several hours, in order that the small particles of caustic soda remaining in the pores of the metal can dissolve. The following day, the components are removed from the water tanks and hand-washed with sponges. It is not necessary to scrub them with metal brushes, as parts de-enamelled by fused caustic method are perfectly clean. It is essential to maintain the caustic soda at a temperature of about 500° C in order to obtain satisfactory results in the de-enamelling process.

It is preferable to eliminate as much sludge as possible. The cleaner the caustic is, the better the parts will de-enamel. Therefore, after 5 tons of components have been de-enamelled, that is after two or three days of continuous de-enamelling, the sludge is precipitated and the sludge tray removed. For this operation, a pneumatic hoist, carried on a monorail placed above the de-enamelling tank, is used. The sludge tray is approximately the same size as the bottom of the tank and holes, pierced in the lower part of the tray's edges are provided for the drainage of any caustic that it may contain. The sludge tray is slowly lifted out of the tank and then lowered on a swinging frame which is installed on a small tank. The tray then tilts and empties into this tank. Once this operation is completed, the tray is replaced in the de-enamelling tank and new caustic soda added until the desired level is obtained. The temperature is then brought up to 500° C and the caustic is again ready for de-enamelling. The entire operation requires approximately ½ an hour.

Once the sludge has cooled off in the small tank provided for that purpose, this tank is emptied by breaking the solidified sludge which is emptied into the old caustic barrels and disposed of suitably.

This purification of the caustic by lifting of sludge trays has been found insufficient. Therefore, a more effective system for elimination of the sludge has been provided. Every five to six weeks a "partial draining" is effected. The purpose of this draining is completely to recondition the caustic soda and at the same time to recover the maximum amount of caustic. After having precipitated the sludge in order to obtain a satisfactory decantation of the sludge, the good caustic is pumped into a "pre-heating" tank which consists of a cylindrical tank buried and placed in a vertical position. A tube, equipped with a universal joint, emerges from this tank and a removable, U-shaped tube, the end of which immerses in the de-enamelling tank, when in place, is also connected to this universal joint. For this "pre-heating" tank, the same heating system as for the de-enamelling tank is used.

After the temperature has dropped, and the caustic is decanted, the tube coming from the "pre-heating" tank is connected by means of the universal joint to the tube immersed in the de-enamelling tank. The end of the tube immersed in the de-enamelling tank should come just above the level of the sludge contained in the tank; then the good caustic is drawn into the "pre-heating" tank by suction. This caustic is later to be re-used. Once this operation is completed, only the sludge remains in the de-enamelling tank. It is removed from the bottom of the tank by means of sliding tubes provided for this purpose. The tube aperture for removal of the sludge is then opened and the sludge flows out into old barrels placed on small wagons circulating on rails and placed in the pits provided. Once all the sludge has been run off, the tubes are closed. After the sludge has cooled off, the barrels are pulled out of the pit by hand-winch and scraped. The tank is now completely empty.

It is then filled and the caustic soda previously recuperated in the pre-heating tank is sucked back into the de-enamelling tank through the same tube previously used for suction into the "pre-heating" tank; very little caustic soda has to be added in the de-enamelling tank. Before starting the partial draining operation of the de-enamelling tank, the amount of sludge to be eliminated is removed and an equal amount of caustic introduced in the "pre-heating" tank a few hours in advance, so that it melts before the start of the operation.

The caustic sucked from the de-enamelling tank mixes with the new caustic, introduced in advance in the "pre-heating" tank, and pre-heated. When the caustic is sucked back into the de-enamelling tank, the required level is almost exact. However, it may be necessary to add a barrel of new caustic

directly into the de-enamelling tank. This partial emptying operation requires approximately one hour.

Periods of time lost for all these operations are very short and the loss of soda is particularly small. The loss of caustic removed with the sludge is estimated to be approximately only 15 per cent. For a plant of this type, the average monthly caustic consumption is 6·8 tons for 20 days of effective work and a production of 1·8 to 2·5 tons daily.

As electricity is almost completely eliminated from the plant, troubles due to short circuits caused by accumulations of caustic-soda dust are avoided. Compressed air is used to the maximum extent due to its cheapness and there is little risk of breaking down; further, it requires no maintenance. The labour force for a daily output of 2·5 tons, in an 8-hour shift, is four men. One man is responsible for the performance of the caustic and the operation of the rack. Two are employed for the washing of de-enamelled components and another one, for the washing and manipulation of components. The labour costs are thus quite low.

The amount of operating equipment that will wear out is very limited. The tank itself lasts several years; in fact in the plant described the tank has been in operation for four years and it is not planned to replace it yet. The sludge tray and the tubes used for heating the tank are replaced every three months and five months respectively. A second tank may be added without increase in installation costs other than that of the second tank. The production can thus be doubled and can then reach five tons per day.

This method of de-enamelling by fused caustic has been employed for four years without accident and has proved very satisfactory. This success is due primarily to the perfected mechanism which eliminates, for the personnel, all dangers in the use of caustic soda. This success is further due to the low operating cost obtained by the utilization of a limited number of personnel and to the low wear of the equipment which can be kept in service for several years.

Vitreous Enamelling in Australia

(*Continued from page* 478)

taking place in the enamelling industry, will offset any present or future challenge.

A trend that is gaining considerable support is architectural enamelling. This architectural enamel field is still in its infancy in this country, but the future outlook is considered to be particularly bright. The advent of curtain-wall construction is proving a boon to the industry, and this type of construction, can lead to an increasing demand for panelling of this nature.

This potential expansion can be attributed broadly to the following factors:—

(1) Increased sales promotion by architects and enamellers along the following lines:—
   (*a*) Ease of erection.
   (*b*) Durability.
   (*c*) Economy—less maintenance.
   (*d*) Decorative appeal.
(2) Customer attraction to buildings already erected in enamelled panels.
(3) Perfection and introduction of enamels particularly suited to this field of enamelling, namely:
   (*a*) Matt finishes.
   (*b*) Acid-resisting enamels.
   (*c*) Enamels for aluminium.
(4) Improvement in the design and fabrication of sheet-metal panels.

It is estimated that the amount of enamelled panels going on to buildings during the coming year will be equal to the total footage of architectural enamelled panels erected over the past seven years. This estimate suggests without doubt that the expansion in this field of construction is without limits.

As to the future of the industry, Australia is looking confidently ahead. The industry's future is bound up in the future of the Country, and Australia has already started to expand and go ahead very rapidly.

ATLAS OF ENAMEL DEFECTS

New I.V.E. Publication

METAL finishing processes are capable of giving rise to a wide variety of different types of defect in the final coating and it is particularly desirable that a standard form of nomenclature for such defects should be laid down to avoid misunderstanding. An incorrect or misleading definition of a defect greatly increases the difficulty of tracing its source. In order to assist users of enamelled ware in the correct recognition and classification of defects, an Atlas has been prepared by a special Sub-Committee of the Technical Committee of the Institute of Vitreous Enamellers. This takes the form of illustrations of over 20 defects associated with cover coats and ground coats on both sheet and cast iron. Each illustration is accompanied by its accepted definition, a brief verbal description, and suggestions of possible causes.

Copies have been circulated to all members of the Institute and further copies are available from the Secretary, price 10s. 6d. (members) and two guineas (non-members).

FINISHING

NEWS REVIEW

APPRENTICESHIP IN METAL FINISHING

Draft Scheme presented to Industry

THE URGENT need for stimulating the supply of trained personnel to the electroplating industry has been voiced very frequently over the past year or two, and in order to make some contribution towards meeting this need, discussions have been in train for some time now between representatives of the Metal Finishing Association, the Institute of Metal Finishing and City and Guilds of London.

As a result of this collaboration a draft has been drawn up for an apprenticeship scheme for the benefit of all those engaged in the electroplating and allied industries. This draft scheme was submitted to a meeting held at the Midland Hotel, Birmingham, on December 4, which was attended by a number of representatives of the metal finishing industry and of trade Associations associated with that industry.

The National Chairman of the Metal Finishing Association, Mr. A. E. Abbott, presided at this meeting and pointed out to those present that the reasons which had promoted the work on the National scheme should be abundantly clear to all concerned. The British Non-Ferrous Metals Research Association had recently published a report on Productivity in the Industry as a result of an investigation financed by Mutual Aid Funds. In the course of this report it had been stated that the standard of technical knowledge of operators, including foremen and charge hands in the industry was, in general, below that which should be expected. Mr. Abbott said that it was hoped that the proposed apprenticeship scheme would make a long-term contribution towards rectifying this deficiency.

There was, moreover, a considerable exchange of labour between the metal finishing departments of manufacturing firms and the outwork plating trade. The provision of a National Certificate as evidence of a level of proficiency would considerably facilitate the task of employers when engaging new labour.

There could be no doubt also that the establishment at an appropriate level of a Nationally agreed standard of training would inevitably raise the efficiency of the industry as a whole and should make some contribution to the reduction of costs.

Mr. Abbott said that it was proposed that responsibility for the administration of the apprenticeship scheme should be vested in a National Joint Council which would be set up for that purpose. The Joint Council would require to be satisfied that an electroplating or metal-finishing employer, in order to qualify as being suitable for training apprentices, had an electroplating or metal finishing shop or department which met their requirements and was, in addition, willing to provide facilities for specialized training, either on his own premises or by granting time off in working hours for instruction to be obtained elsewhere.

The Joint Council would keep a register of approved employers and apprentices and all employers desiring to take on apprentices would first apply for registration.

The period of apprenticeship would normally be five years, from school leaving age until the apprentice reached the age of twenty-one.

Those present at the meeting signified their approval of the proposal to set up an apprenticeship scheme for the metal finishing and allied industries, and it was agreed that a National Joint Council to administer the scheme should be created forthwith. The Council would include representatives of the Metal Finishing Association, the Institute of Metal Finishing, and certain other trade associations interested in forwarding the scheme.

LONDON PLATERS' ANNUAL DINNER

Record Attendance

THE Annual Dinner and Dance of the London Branch of the Institute of Metal Finishing was held at the Waldorf Hotel on December 7. This function is traditionally the first of the Branch Social occasions on the calendar of the Institute, and over past years has attracted an ever-increasing attendance.

This year's function once again surpassed the numbers of previous years with an attendance of 215. One reason for the continued popularity of this function is undoubtedly the informality of the proceedings, as no formal speeches are included in the programme to delay the opening of the dance. In a few very brief remarks the chairman of the Branch, Dr. G. L. J. Bailey, welcomed the company, which included the President of the Institute, Mr. R. A. F. Hammond and Mrs. Hammond. Dr. Bailey also paid tribute to the work of the Branch Social Sub-Committee under the chairmanship of Mr. Arthur Lupson, which had been responsible for organizing all details of the function.

During the dancing, which continued until 1 a.m., a number of spot prizes were awarded, which had been made available through the generosity of certain member firms.

BATH NIGHT ON TV

ONCE again the vitreous enamelling process constituted an important part of a television programme. On November 15 the B.B.C. television cameras visited a large and well-known Scottish foundry, where viewers were able to watch the casting of bath tubs and their subsequent enamelling by the dry process. The dusting of the dry enamel frit on to the red-hot castings, showed up in a quite spectacular manner on the television screens and gave a very real indication of the way in which this high-quality finish is applied to cast iron.

Preparation of Steel Structures for Painting

CURRENT progress of Jenolite activities in the U.S.A. was reflected recently in an invitation from the National Association of Corrosion Engineers for the company to submit a paper at a conference in Philadelphia, Penn., which was attended by over 200 delegates, including many from New England and the South.

The paper, prepared by Jenolite Technical Department in London, was presented by Mr. Henry W. Adams of Atlantic Laboratories of Delaware Incorporated, of Wilmington, Del., the Jenolite agents for the eastern states.

Subject of the paper was the preparation of steel structures for painting with the use of chemical processes. It considered not only the technical aspects of millscale, rust and paint failure, but also how the effect of many methods of dealing with them is often nullified by such factors as work schedules and delays common to most building sites. This led to examination of some of the advantages of chemical treatments in coping with this problem.

Film of Plating Plant

In line with the current interest in continuous plating, a film has been produced showing automatic plants for electroplating and other metal-finishing processes in actual operation on production by Silvercrown Ltd., 178 Goswell Road, London, E.C.1.

The 16 mm. film has a running time of approximately 10 minutes and is available on loan.

TREATING TRADE WASTES

Course Will Also Deal With Prevention of River Pollution

IT is proposed to hold a residential course on "The Treatment of Trade Wastes and the Prevention of River Pollution" at the Department of Civil Engineering, King's College, Newcastle-upon-Tyne, from April 1 to 12, 1957. This course is designed to meet the needs of those in industry who have to deal with the problem of disposing of liquid effluents, as well as those of officers of Local Authorities and of River Boards.

Accommodation has been arranged at Lumley Castle (University College, Durham); buses will bring members of the course to Newcastle each morning and return to Lumley each evening.

The lectures will be given by authorities in this field; and in addition there will be visits and demonstrations.

The fee for the course, which will include the cost of all visits, morning coffee, lunch and afternoon teas during the course, will be about eighteen guineas. The cost of accommodation at Lumley Castle, which will cover bed and breakfast, week-end meals, and bus transport will be about £15 (including gratuities).

Further information may be had from Mr. P. C. G. Isaac, B.Sc., S.M. M.I.C.E., F.R.S.H., senior lecturer in Public Health Engineering, Department of Civil Engineering, King's College, Newcastle-upon-Tyne.

There will be 16 lectures which will cover: A Survey of the Problem of Trade-Waste Waters; River Pollution—general, chemical effects and biological effects; Discharge of Trade Wastes—the legal position; The Impact of Trade Wastes on Sewage-Treatment Practice; A Survey of Trade-Waste Treatment; Analytical Methods for Trade-Waste Waters; Biological Filtration in the Treatment of Biological and non-Biological Wastes; Activated Sludge for the Treatment of Trade Wastes; Chemical Methods for the Treatment of Trade Wastes; Physical Methods for the Treatment of Trade Wastes; Treatment-Plant Engineering; and Current Research in the Public Health Engineering Section of the Department of Civil Engineering of King's College, Newcastle.

In addition to the lectures there will be visits to a local stream to show the biological effects of trade-waste waters; the River Tyne to show gross pollution of an estuary; and others to demonstrate the work of River Boards and of industry in dealing with trade wastes.

During the course there will be demonstrations of instruments and equipment for the analysis and control of trade wastes; laboratory tests on trade wastes; and laboratory-scale plant for the investigation of trade wastes.

Reorganization Means Accent on Industrial and Transport Finishes

IT has been announced by Vulcan Products Ltd. that they have ceased production of their decorating range of paints and finishes, except for factory maintenance work.

This move has been undertaken to allow the company to fulfil its function with the Blundell Group by concentrating its production, research and sales activities exclusively on industrial and transport finishes.

Demand for both industrial and transport finishes has increased so considerably that expansion of production facilities has become essential. By ceasing manufacture of its decorating range the company will now be able to double production of its industrial and transport finishes and to maintain the high quality associated with its products.

The reorganization also means that customers can now be offered improved service and facilities from the sales staff and by the company's industrial and transport technical advisory service.

PRODUCTIVITY IN METAL FINISHING

THE Midland Branch of the Institute of Metal Finishing is organizing a competition to encourage younger members to take an interest in productivity in the metal-finishing industry. The subject of the competition is plating-shop layout and candidates will be supplied with an outline of a plating shop and a list of process tanks and plant which they will have to incorporate in the design.

They will have to lay out the shop so that it would be capable of handling the normal variety of work encountered in a jobbing shop with the maximum efficiency possible. Three main prizes will be awarded: First £30, Second £20, Third £10.

The branch feels that it is very important for young men in the metal-finishing industry or on the fringe of it to be encouraged to take a real and live interest in metal-finishing problems and to play an active part in the development of the industry. Entry is restricted therefore to members of the Institute who are aged not more than 35 on December 31, 1956.

LARGE SCALE PLANS TO EXPAND NICKEL PRODUCTION IN CANADA

British Company Increases Prices

FOLLOWING the simultaneous announcements in Canada by The International Nickel Co. of Canada Ltd. of its project in Manitoba for opening two new nickel mines and of an increase in the price of nickel effective December 6, the Mond Nickel Co. Ltd. has raised its price for refined nickel in the U.K. to £600 per ton delivered works with appropriate increases for other countries.

Plans for the development over the next three to four years of a $175,000,000 nickel project in the Mystery-Moak Lakes area in Northern Manitoba were announced here by Premier Douglas Campbell of Manitoba and Henry S. Wingate, President of The International Nickel Co. of Canada Ltd.

International Nickel will open two new nickel mines in the area, to be known as the Thompson and the Moak Mines. The project will constitute the biggest nickel-producing operation in the world next to Inco's operations in the Sudbury District of Ontario and will be the largest single investment of any kind in Manitoba.

The project in Manitoba together with the progress under way at Sudbury will lift Inco's regular 1955 annual nickel-producing capacity by approximately 130,000,000 pounds to 385,000,000 pounds, or by 50 per cent., of which some 24,000,000 pounds will be regular production to replace existing temporary premium-priced production for the United States national stockpile.

The joint announcement was made with the conclusion of understandings between the Province and Inco including an agreement for the establishment of a new local government district of Mystery Lake and an agreement with the Manitoba Hydro-Electric Board. The Hydro agreement provides that the Board will undertake construction, at an estimated cost of $32,000,000 to $38,000,000, of a large power plant at Grand Rapid on the Nelson River to supply power for Inco's new facilities. The capacity of the hydro-electric plant will be sufficient to supply Inco's initial and subsequent power needs, with reserves for other new industries.

The new mining development will contribute greatly to the very much larger supply of nickel which the free world can expect by 1960, and the company expects to attain an annual over-all regular nickel production capacity of 385,000,000 pounds from its operations in the Sudbury District of Northern Ontario and in Manitoba. In 1955 the total Inco Sudbury District nickel production from its own ores was nearly 280,000,000 pounds, consisting of approximately 255,000,000 pounds of regular production and 24,000,000 pounds of special production from high-cost ores for the United States Government stockpile.

Since the Manitoba ores carry very small copper values, Inco's copper production capacity will not be increased correspondingly with the large increase for nickel. Previously copper production had been nearly as large as nickel production. In view of the costs of separating and refining the copper from the Manitoba ores, the copper content was not regarded as a commercial asset. Minor quantities of cobalt, platinum, palladium, gold and silver were present to assist in making the project successful.

The Inco President forecast on the basis of Inco's programme and the announced expansion plans of others that total free world nickel capacity four years from now may be 600,000,000 to 625,000,000 pounds. With the achievement of this world capacity the total free world capacity for nickel supplies should exceed civilian consumption during the 12 months ended September 30, 1956, by more than 325,000,000 pounds. This large amount will be available for the unsatisfied and expanded needs of civilian industry and for whatever the defence requirements may be at that time. It is evident that a huge demand must be provided to sustain the projected enlarged capacities.

He added that hand in hand with the extensive production project and continuation of active exploration for still further sources of nickel, the company was going forward energetically with market development and research so as to do everything possible to stimulate the growth of further markets and uses for nickel. In the face of the need for greatly expanded future demand for the metal he hoped that other producers would not confine their efforts solely to the production of nickel but make a major contribution also by actively pursuing long-range research and development of uses and markets.

Motors on the Wall

TWO students of the Huddersfield Technical College had the distinction of seeing the effects of their own exercise in wallpaper design and printing displayed on a stand at this year's Motor Show. Earlier in the year the associated companies of Robt. Ingham Clark and Co. and R. Gay and Co. co-operated in an exhibition arranged by the head of the college's painting and decorating department, who agreed to a suggestion from Robt. Ingham Clark and Co. that he should set his students a practical exercise in designing wallpaper with a motoring motif.

The two students, W. Fiddes and G. Knight, are pictured above with Mrs. Anne Hall, the well-known motor rally driver. They were entertained by the company in London.

Technical and Industrial Appointments

Jenson and Nicholson Ltd. have appointed Mr. A. J. Jewell, F.C.I.S., F.A.C.C., F.C.W.A., as a director, and Mr. E. E. Bamber, A.C.A., as secretary to the company.

Mr. Jewell joined the company in 1928 and in 1941 became chief accountant.

Mr. Bamber joined the company in 1946 when he left the Army.

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Mr. R. M. C. Nunneley has been appointed general manager of **Coates Bros. Inks Ltd.** and has also accepted an invitation to join the board of the parent company, **Coates Brothers and Co. Ltd.**

* * *

Mr. Edward H. Jacobs has been appointed works manager of **Abrasive Machine Tool Co.,** East Providence, Rhode Island, U.S.A. Mr. Douglas MacLeod, Jnr., executive vice-president, pointed out that Mr. Jacobs' chief responsibility will be supervision of production of the company's broad line of precision surface grinders.

* * *

Mr. Donald MacPhail has been appointed managing director of **Dictaphone Co. Ltd.** He succeeds Mr. Robert W. Belcher, an American, who will be returning to the parent company in the United States.

Mr. MacPhail left the board of Indestructible Paint Co. Ltd. to take up his new position.

* * *

At the **Pennsylvania Ceramics Association** board of directors meeting held in Pittsburgh, Mr. E. M. Hommel, president of the O. Hommel Co., Pittsburgh, Pennsylvania, was elected first vice-president.

In this capacity Mr. Hommel will take over the duties of general chairman of the many important committees involved in the betterment of the growing ceramics industry in the Pennsylvania State area.

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Amber Pharmaceuticals Ltd. have appointed Mr. Francis de Buda to the board of the company.

STOPPING RUST BUT ALLOWING SPOT WELDING

New Process Installed at Austin Works

WITH the increase of automation in the motor-car industry, finishing processes are becoming more and more exacting in their demands for techniques which do not require hand work. In the previous cleaning cycles it was found necessary sometimes to take out complete bodies after assembly and on non-automatic processes this was possible. With the introduction of automation it has become necessary that the finishing processes should also be automatic.

Automatic priming and finishing raises difficulties where cleaning and protective aids are used which will not easily allow spot welding or where deep phosphating is included after assembly and prior to finishing.

Not all of the pre-treatment work can be undertaken as an automatic process and in certain cases it is better to instal de-greasing, de-rusting and protective processes for metal parts prior to assembly so that the normal cleaning by automatic means may be carried out after assembly.

At the Longbridge Works of the Austin Motor Company, metal parts are freed from rust or grease and receive a two-fold protection by the Spiero process. In this instance this is a six-tank process which gives not only speed of operation, but produces a bright-steel finish that allows spot welding to be undertaken during assembly. After assembly the bodies are made ready to be put through their automatic cleaning plant and to receive a final deep phosphating.

The use of the process at this early stage means that Austin's can ensure that automatic processes are not stopped through having to take out single reject items and at the same time gives cleanliness and freedom from rust.

Several advantages are claimed for the process. The chemicals are non-toxic and in many instances the process is more than 50 per cent. cheaper than by other methods. Every case is dealt with on its own merits making it possible to use just one tank process for a particular requirement or the whole cleaning operation.

"GAS AT WORK IN INDUSTRY"

EVERY phase of the application of gas in industry is to be displayed at the Royal Horticultural Hall, London, from January 22 to February 2, 1957.

This exhibition will be the first of its kind and is being organized by four Area Gas Boards—North Thames, South Eastern, Southern and Eastern.

Awards For Essays on Corrosion Science

THE Education Panel of the Corrosion Group, with the approval of the Council of the Society of Chemical Industry, last year established a competition designed to encourage those who are still in the early stages of their career to take an interest in corrosion science and to express their ideas in writing. With the support of industrialists interested in the application of corrosion science in industry, a prize of 25 guineas will again be awarded this year for an essay or paper on any aspect of corrosion of metals and its prevention.

Essays are invited from persons aged not more than 27 years on the closing date, March 31, 1957. A length about 4,000 words is suggested, but reasonable latitude is allowable.

Judgment of the entries by judges appointed by the Education Panel Committee will be based on the evidence shown of the candidate's critical faculty and originality of thought, and on technical and literary excellence generally. Results of original research may be incorporated, but this is not essential; entries may consist, for example, of surveys of knowledge in a particular field, discussion of practical problems, and suggestions for future developments in research, in application of knowledge, or in organization of corrosion-preventive measures. Where the work or ideas of others are referred to, clear acknowledgment must be made.

A successful candidate may subsequently be invited to deliver his or her contribution as a lecture.

Electroplating Course

A practical course on control of electroplating solutions will be held in the Department of Chemistry, **Brighton Technical College,** on Monday evenings, 7-9 p.m., for a period of 13 weeks from January 7, 1957. Lecturers: B. Bush, B.Sc., and R. Pinner, B.Sc. Fee for the course, £1. Applications for enrolment should be made as soon as possible to the Head of the Department of Chemistry.

1,500 USES FOR GLYCERINE

End of Post-War Shortage

ALTHOUGH it occurs largely as a by-product of the soap-making and fat-splitting industries, glycerine is a material of vital importance to a very wide range of industries. Its particular importance in the manufacture of certain explosives led to a shortage during the second world war. After the war, glycerine continued in short supply because two new industries, transparent paper and paint resins, underwent a rapid expansion. At the same time the supply of natural glycerine failed to keep pace with the increasing demand, because of the growing use of soapless detergents, which do not produce glycerine as a by-product of their manufacture.

The shortage of glycerine and its resultant high price led to the development of plants for the manufacture of synthetic glycerine, with the result that at the present time, all foreseeable requirements can be met.

The end of the period of shortage has enabled the U.K. Glycerine Producers' Association to launch a campaign to publicize new and improved methods of glycerine application. One of the recent acts of the Association has been the publication of a booklet listing some 1,500 uses for glycerine under the various appropriate technical and industrial heads.

Beginning in January, a periodic bulletin "Glycerine Facts", will be published, which will include information on new developments, patents and research in this country and elsewhere. It is hoped that these publications will assist in the development of even wider use and further applications of glycerine.

Copies of the booklet may be obtained on application to the offices of the Association at 43 Portman Square, London, W.1.

COLOUR MAKERS' ANNUAL DINNER

THE seventh Annual Dinner of the British Colour Makers' Association was held at the May Fair Hotel, London, on November 14. Mr. H. Gosling (Cornbrook Chemical Co. Ltd.) retiring chairman of the Association, presided at the function at which 46 representatives of members and staff of the Association were present. Mr. C. W. A. Mundy, president of the Oil and Colour Chemists' Association was principal guest.

The Annual General meeting of the Association was held on the following day, at which the officers and Council for the ensuing year were appointed as follows: Chairman: Mr. A. H. Whitaker (James Anderson and Co. (Colours) Ltd.); vice-chairman: Mr. V. Watson (Cromford Colour Co. Ltd.); honorary treasurer: Mr. C. G. A. Cowan (Cowan Bros. (Stratford) Ltd.); Council: Mr. C. M. Beavis (Golden Valley Colours Ltd.), Mr. A. S. Callaghan (Imperial Chemical Industries Ltd., dyestuffs division), Mr. C. G. A. Cowan (Cowan Bros. (Stratford) Ltd.), Mr. G. E. Hillier (J. W. and T. A. Smith Ltd.), Mr. H. Gosling (Cornbrook Chemical Co. Ltd.), Mr. J. H. Grimshaw (Horace Cory and Co. Ltd.), Mr. V. Watson (Cromford Colour Co. Ltd.), Mr. A. H. Whitaker (James Anderson and Co. (Colours) Ltd.), Mr. H. A. Wilson (The Derby-Oxide and Colour Co. Ltd.); Secretary: Mr. A. J. Holden, B.Sc., F.R.I.C.

OBITUARY

Brown: Mr. Malcolm Brown, managing director of Metals and Methods Ltd., Slough, Bucks., died on November 14 after a short illness.

Partridge: The death has occurred of Dr. John H. Partridge, well-known as a specialist in the technology of glass and refractories. A former secretary of the Society of Glass Technology for many years, he was elected president of that body in April of this year. Trained as a metallurgist, Dr. Partridge had been responsible at the Research Laboratories of the General Electric Co. Ltd. for many of their glass developments, particularly in the field of glass-to-metal joints.

CHANGE OF ADDRESS

We are informed by the **Copper Development Association** that they have moved from their offices at Radlett, and that their new address is 55 South Audley Street, London, W.1. Telephone: GROsvenor 8811.

MEETING OF BRITISH PAINT MANUFACTURERS

AT the twelfth annual general meeting of the Society of British Paint Manufacturers Ltd., held at the Dorchester Hotel, London, on Wednesday, November 7, it was announced that Mr. C. D. O'Sullivan had been reappointed president, and Mr. T. S. Dally vice-president for the year 1956-57.

The five vacancies on the council were filled by the election of Mr. F. W. Burmann (General and Industrial Paints Ltd.); Mr. C. A. Carter (Indestructible Paint Co. Ltd.); Mr. B. J. Nicholson (Jenson and Nicholson Ltd.); Mr. E. Lloyd Rolfe (Aspinalls (Paints) Ltd.); and Mr. W. J. Shilcock (Cellon Ltd.). Mr. F. A. Bignell was reappointed honorary treasurer, and Lithgow, Nelson and Co. were reappointed auditors.

NEW D.S.I.R. RESEARCH COUNCIL

BY Order-in-Council, dated October 31, 1956, Her Majesty approved November 7 as the date on which the Department of Scientific and Industrial Research Act, 1956, should come into force.

The composition of the new Council is: Sir Harry Jephcott, D.Sc., F.R.I.C. (chairman)—chairman, Glaxo Laboratories Ltd.; Sir Eric Ashby, D.Sc., Sc.D. president and vice-chancellor, The Queen's University of Belfast; Prof. C. E. H. Bawn, C.B.E., Ph.D., F.R.S. Grant-Brunner, Professor of Inorganic and Physical Chemistry, University of Liverpool; Sir Hugh Beaver, K.B.E., M.I.C.E., M.I.Chem.E., managing director, Arthur Guiness, Son and Co. Ltd.; Prof. P. M. S. Blackett, M.A., D.Sc., F.R.S. Professor of Physics, Imperial College of Science and Technology, University of London; Mr. H. Douglas, general secretary, Iron and Steel Trades Confederation; Sir Walter Drummond, M.I.C.E., M.I.Mech.E., director of George Angus and Co. Ltd., and also Smith's Dock Co. Ltd.; Mr. W. L. Heywood, O.B.E., general secretary, National Union of Dyers, Bleachers and Textile Workers; Dr. Willis Jackson, M.I.E.E., M.I.Mech.E., F.R.S., director of Research and Education, Metropolitan-Vickers Electrical Co. Ltd.; Sir Philip Johnson, D.Sc., deputy chairman, R. and W. Hawthorn, Leslie and Co. Ltd.; Prof. E. A. G. Robinson, C.M.G., O.B.E., M.A., Professor of Economics, University of Cambridge; and Dr. H. W. Melville, F.R.S., the secretary of the present Advisory Council, who will be Secretary of the new Council.

Meetings of the Month

DECEMBER 17

Institute of Metal Finishing (London Branch). "Metal Cleaning" by D.R. Newman and J.E. Entwhistle at the Northampton Polytechnic, St. John Street, London, E.C.1 at 6.15 p.m.

DECEMBER 18

Metal Finishing Association. Luncheon Meeting. Open Discussion, Farcroft Hotel, Rookery Road, Handsworth, Birmingham 21.

JANUARY 1

Institute of Metal Finishing (Midland Branch). "The Chromium Plating of Gun Barrels", by R. A. F. Hammond, B.Sc., A.R.C.S., F.R.I.C., at the James Watt Memorial Institute, Great Charles Street, Birmingham 3, at 6.30 p.m.

JANUARY 5

Institute of Metal Finishing (North - West Branch). Third Annual Dinner and Dance at the Cafe Royal, Manchester.

JANUARY 8

Institute of Metal Finishing (Organic Finishing Group). "New Developments In Electrostatic Painting", a film and paper by R. Tilney, A.M.I.Mech.E., at the British Institute of Management, 8 Hill Street, London, W.1, at 6.30 p.m.

JANUARY 9

Society of Chemical Industry (Corrosion Group). "Corrosion Problems In Nuclear Power Production", by A. B. McIntosh, at 14 Belgrave Square, London, S.W.1, at 6.30 p.m.

Institute of Vitreous Enamellers (Southern Section). "Consumer Standards of Acceptance for Vitreous Enamelled Ware", by B. B. Kent, at the Howard Hotel, Norfolk Street, Strand, W.C.2, at 7.15 p.m.

JANUARY 11

(Institute of Vitreous Enamellers (Midland Section). Annual Dinner at the Station Hotel, Dudley.

JANUARY 12

Oil and Colour Chemists' Association (Scottish Junior Subsection). "Flotation", by R. J. Cole, B.Sc., F.R.I.C., A.M.I.Chem.E., in More's Hotel, India Street, Glasgow, at 10 a.m.

JANUARY 15

Metal Finishing Association. Luncheon Meeting. Speaker: Peter Cranmer, at the Farcroft Hotel, Rookery Road, Handsworth, Birmingham 21.

JANUARY 21

Institute of Metal Finishing (London Branch). "The Chromium Plating of Gun Barrels", by R. A. F. Hammond, B.Sc., A.R.C.S., F.R.I.C., at the Northampton Polytechnic, St. John Street, London, E.C.1, at 6.15 p.m.

JANUARY 25

Institute of Metal Finishing (Sheffield and North-East Branch). General debate on plating problems with J. H. Woods in the chair at the Grand Hotel, Fitzwilliam Room, Sheffield, at 7 p.m.

TRADE and TECHNICAL PUBLICATIONS

Wrought Titanium: This booklet published by the Imperial Chemical Industries Ltd., P.O. Box 216, Kynoch Works, Witton, Birmingham 6, describes the uses of titanium. It states that the company have pioneered the production of metallic titanium in this country.

The physical and mechanical properties are dealt with as well as its future developments; resistance to corrosion; machining and grinding; hot working; forming; welding, brazing and soldering.

In the section on "Descaling and Surface Treatment" it states that all types of scale may be removed in fused caustic soda, but use of an unmodified bath leads to hydrogen contamination and to poor surface quality. With an appropriate immersion time the hardened metal layer beneath the scale may be removed in the oxidizing bath, since metal dissolution occurs at about the same rate as removal of scale; otherwise metal should be removed by acid pickling, preferably in a bath containing 4 per cent. hyfrofluoric acid with 20 per cent. nitric acid at 50° C.

Information is also given on electrodeposition, the simplest method being to etch the work in hydrochloric acid, flash in a cyanide copper bath and then plate in a conventional manner.

Titanium can be anodized in almost any aqueous solution, and although it has no affinity for dyestuffs, the film itself shows interference colours determined by the final anodizing potential. When anodized, very little electric current flows from titanium once the film is fully formed, but the surface is capable of passing current to a conductor pressed lightly against it.

Nickel Plating for Engineers: As its title implies this new publication of The Mond Nickel Co. Ltd., Thames House, Millbank, London, S.W.1, has been written primarily for engineers, designers, and others who are interested in the possibilities which plating offers in design.

No attempt has been made to cover in great detail nickel plating procedures themselves, but sufficient information is given concerning the various practices to indicate how these affect the properties of the resultant deposits. The text includes a description of methods of surface preparation for plating in general and for plating on zinc-base alloys, aluminium, and nickel-chromium iron alloys in particular. Useful information is also included on methods of testing nickel deposits and on some typical applications of the deposit. Methods of machining and grinding are also referred to. Much of the information is presented in graphical or tabular form, for ease of reference.

Copies of the publication are obtainable from The Mond Nickel Co. Ltd. free of charge.

"Guide to Aluminium Paint": The differences between the finishes that are obtainable by the use of various grades of aluminium paste pigment are difficult to describe or visualize, so a useful guide to the selection of the most suitable pigment for a particular purpose has been produced in the form of a folder by The Northern Aluminium Co. Ltd., Banbury, Oxford. This folder incorporates eight panels which have been prepared by spraying with the appropriate pigment in a typical commercial paint vehicle, and the various panels indicate very clearly the different degrees of specular reflectivity and whiteness which can be obtained with the various grades.

Copies of the folder can be obtained from the company who recommend that it be studied in conjunction with a leaflet entitled "Noral Alpaste —New Developments".

Plater's Calculator: The current issue of Canning Quarterly News, house organ of W. Canning and Co. Ltd., Great Hampton Street, Birmingham 18, includes a reference to a plater's calculator recently produced by the company. This is a simple device, which enables an electroplater to determine the time necessary to deposit a given thickness of metal at various current densities, thus eliminating the need for calculation. The company will be pleased to send one of these calculators to any electroplater making application to them.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Bright-anodized Aluminium for Decorative Trim

"BRIGHT-ANODIZED" aluminium is a development that now seems on the point of acquiring considerable commercial importance in the United Kingdom, largely as a result of recent improvements in brightening and anodizing processes. This material, which is already in use for motor-car trim—extensively on the Continent and in a small way here—has a higher reflectivity than nickel-chromium plate—83 per cent. total reflectivity as against 63 per cent. The cost of the basis metal is lower than that of brass and, although it is higher than that of steel, the finished article in bright-anodized aluminium is generally competitive in price with its chromium-plated counterpart in either metal. A particular advantage is that damage to the film (which is very hard) does not result in discolouration, since the underlying metal is exceptionally resistant to corrosive attack. Moreover, if desired, it is possible to tint the film in a range of light-fast colours, including a brilliant gold.

The brightening may be electro-chemical (of which the Brytal and Alzak methods are probably the best-known) or chemical (the Erftwerk process here being the most fully-developed). Although the electrochemical processes give the more mirror-like finishes, the Erftwerk process, which is essentially a chemical dip, has a greater smoothing action and therefore holds out more promise of a reduction in the cost of the mechanical pre-polishing necessary for most applications.

Fig. 1—Bright-anodized aluminium

For bright-anodizing the aluminium must be of high purity; 99·99 per cent. pure metal, known as "super-purity aluminium", is used for a wide variety of purposes ranging from reflectors for searchlights to costume jewellery and tableware.

For articles in which greater hardness and strength are necessary, super-purity aluminium may be alloyed with magnesium without any deleterious effect on brightening. Northern Aluminium Co. Ltd., Banbury, Oxon, have recently developed an alloy, Noral D57S, which contains 1½ per cent. magnesium and combines the brightening characteristics of super-purity aluminium with higher strength. It is therefore likely to become one of the most useful materials for decorative ware of all kinds, such as trim and components of motor-cars, commercial vehicles, and cycles, for vacuum cleaners, cookers, refrigerators and other domestic appliances, and for shopfittings and some decorative applications in architecture. Both super-purity aluminium and Noral D57S are available in the form of sheet, strip, and extruded sections.

Barrier Cream

A BARRIER preparation, containing a silicone, has been introduced by Lloyd-Hamol Ltd., 3, St. James's Square, London, S.W.1.

The synthetic silicones which the cream contains are of constant composition and possess five main properties: they are water-repellent, flexible, non-toxic, chemically and physiologically inert, and good dielectric substances.

Over one million days are lost every year through industrial dermatitis and the company claim that the use of this new preparation, known as Syl, which forms an invisible film over the skin and prevents harmful contacts particularly with water-borne irritants, can help in the fight against this affliction.

An important feature of silicones, that is claimed to be preserved in Syl, is the ability to resist penetration by aqueous solutions while being permeable to vapour and gas. The company state that the preparation will protect the skin against attack from acids, alkalies, detergents and aqueous solutions of chemicals, and also it will allow more complete cleaning of allergen-carrying grime from the skin.

The company point out that Syl is primarily protective although it has incorporated in it a non-irritant antiseptic, hexylresorcinol, to bring under control skin inflammation or infection.

(*Continued in page* 490)

Pressure Controllers

A NEW family of seven slack-diaphragm-operated pressure controllers is announced by George Kent Ltd., Luton, Beds. These controllers are all of the non-indicating, non-recording, blind-setting type, and comprise suction or pressure controllers, including a special-purpose furnace-pressure controller; differential-pressure controllers; a special-purpose mill controller; and an air-flow controller or differential-pressure transmitter. The general appearance of all these instruments in the FAF group is similar, as shown in Fig. 2. The instrument door measures 18 x 15 in., and all the FAF instruments are suitable for wall, panel or post mounting, although normally the instruments are not mounted on a panel but near to the operating point.

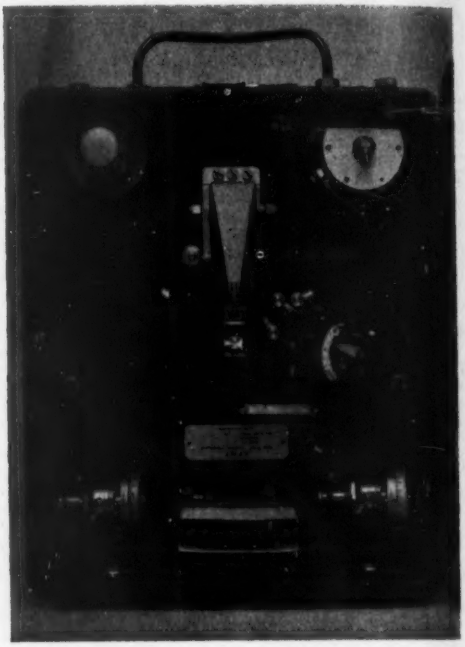


Fig. 2—Slack-diaphragm-operated pressure controller.

Spray-gun Nozzle

A NEW development in spray gun nozzle design has been announced by Alfred Bullows and Sons Ltd., Long Street, Walsall, Staffs. This is called the tangential nozzle and is said to be a major step forward in obtaining the maximum amount of useful work from the air stream to produce a fan spray (Fig. 3).

In a conventional nozzle the energy of the air passing through the fanning arrangements is said to be largely dissipated, because the air parts are opposed, so that the two air streams strike into each other directly, and most of the energy is lost. By using a tangential arrangement of the nozzle horns, the kinetic energy of the discharged air is used to the full, as the two air streams pass tangentially across the face of the nozzle.

It is thus possible to provide a very wide spray and maximum coverage per pass of the gun, while breaking up a given amount of paint, with the minimum consumption of air at minimum pressure. Quite startling savings are claimed on certain applications, particularly with electrostatic deposition, and it is frequently possible to reduce atomizing air pressure from 50 to 5 lb. per sq. in. with improved performance and corresponding savings in air and material.

The tangential nozzle is suitable for use with Bullows L/200, L/500 and L/600 guns, and is interchangeable with other pressure feed set-ups on these guns.

Fig. 3—Spray gun with tangential nozzle.

Lacquer Dispenser

A NEW product designed to give lasting invisible protection for all polished metal surfaces is being marketed by the Pressurised Dispenser Division of Amber Oils Ltd., 11A Albermarle Street, London, W.1, as the latest addition to their range of Amber aersols. This is a clear cellulose lacquer packed in a small aerosol dispenser and marketed under the name Blink

invisible chrome protector. It is claimed that the coating produced by spraying this lacquer on polished metal surfaces will remain intact for several months and is easily maintained by wiping with a damp cloth.

The use of clear lacquer as a means of protecting a chromium-plated surface is well known as a way of preventing deterioration of the plating and the availability of a suitable material in this handy spray package should considerably simplify the application of the lacquer coat.

New Range of Barrelling Equipment

A RECENT newcomer in the barrel-finishing field is the range of barrel deburring and finishing equipment developed by the Armco Division, Queen Stove Works, Inc., Minn., U.S.A., which is now being supplied in this country by the Armco Supersheen Division of Great Britain Ltd., Hitchin, Herts. The new company offers a number of different models of barrel finishing machines and all necessary equipment compounds and abrasive chips.

Illustrated in Fig. 4 are the DB0-1A, the DB-50 and the DB-200 models, which represent part of the available range.

The process consists basically of rotating components such as stampings, die-castings, pressings or quality precision machined components, *i.e.*, jet-turbine blades in a lined octagonal barrel with abrasive chips and water to which soluble chemical compounds are added. The company state that the process eliminates trial-and-error finishing methods because it is controllable to an absolute degree, with results, on a given part, being consistently uniform. Further, by being able to control all operating conditions almost any desired micro-inch surface reading can be obtained and any amount of metal removed.

Many finishing operations may be performed by barrel finishing; these include deburring, grinding, polishing, burnishing, rust inhibiting, degreasing, etc., and savings are claimed for all of these.

The twin-barrelled model DB0-1A is stated to be ideal for a small finishing shop and for companies handling large batches of small parts. The barrels are built into a cabinet that contains a loading and screening drawer for each barrel. A motor is fitted that provides variable speeds from 10 to 50 r.p.m. Also incorporated in the machine is a safety hood, chain guard, safety switch and switch box for full protection and ease of operation when the hood is down, lightweight cast-aluminium door, a per-

(*Continued in page* 492)

Fig. 4.—*Barrelling equipment:* (l. to r.) *models* DB0-1A, DB-50 *and* DB-200

forated drain door for flushing and rinsing and an unloading boot. The drain door and unloading boot are optional, as are split compartment barrels with two compartments 4 in. wide by 16 in. diameter. The normal barrel width is 8 in. giving each barrel a capacity of 1 cu. ft.

Part of the company's "advanced design" series are models DB-50 and DB-200 which include several exclusive features. These are special drive units with class-3 gears, made specially for barrel-finishing equipment, giving a range of speeds from 6 to 30 r.p.m., and a screw-type pressure-release valve which, it is stated, can release, in 15 to 30 seconds, any pressure built up during long grinding cycles; this feature also makes the barrel self-cleaning.

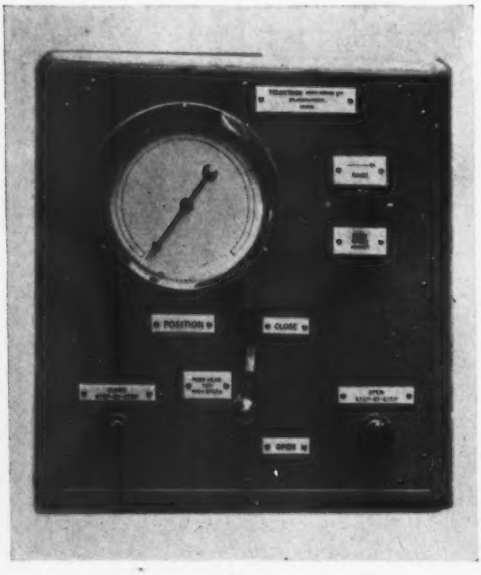
The DB-200 machine has a barrel 30 by 32 in. with either one or two compartments, and a total capacity of 13.8 cu. ft. To help protect the parts being unloaded from damage and to control them is an unloading boot which is an optional extra. An aluminium door is also fitted.

The height of the machine is 74 or 84 in., width 40 in. and length 64 in. It includes manually-operated electric controls, although single and dual timer controls which provide automatic delayed starting and stopping for accurately controlled running cycles are available as optional extras.

Combining all the advantages of the larger "advanced design" series, model DB-50 is for parts that can be handled in a smaller-capacity machine. The drum, 22 in. in diameter and 24 in. long, allows medium quantities of fairly large parts or large quantities of small parts to be processed. With a capacity of 5·6 cu. ft., the barrel is available with one or two compartments, and it operates at speeds from 10 to 30 r.p.m.

Among the many claims made for these machines are: versatility, different finishes can be obtained from one installation; it will pay for itself in less than a year; and will replace from 2 to 12 men.

Fig. 5.—Remote control for valves



Remote Control for Valves

A RECENT development in the control of motorized valves announced by Telektron (Great Britain) Ltd., 109 Jermyn Street, London, S.W.1, has been the design of a small compact control panel which provides the operator with the same flexibility and sensitivity of valve adjustment as can be achieved by manual control of the valve handwheel. The panel illustrated in Fig. 5 provides valve adjustment at both high and low speed, together with step-by-step movement and position indication. The simple standard motorizing unit is fitted to the valve and connected to this control panel by only four small bore air lines. A single valve may be controlled from one or more of these panels arranged in parallel or with a master and secondary panels. The lever-type control provides high- and low-speed operation in either direction, the low speed being adjustable by the operator on the panel face.

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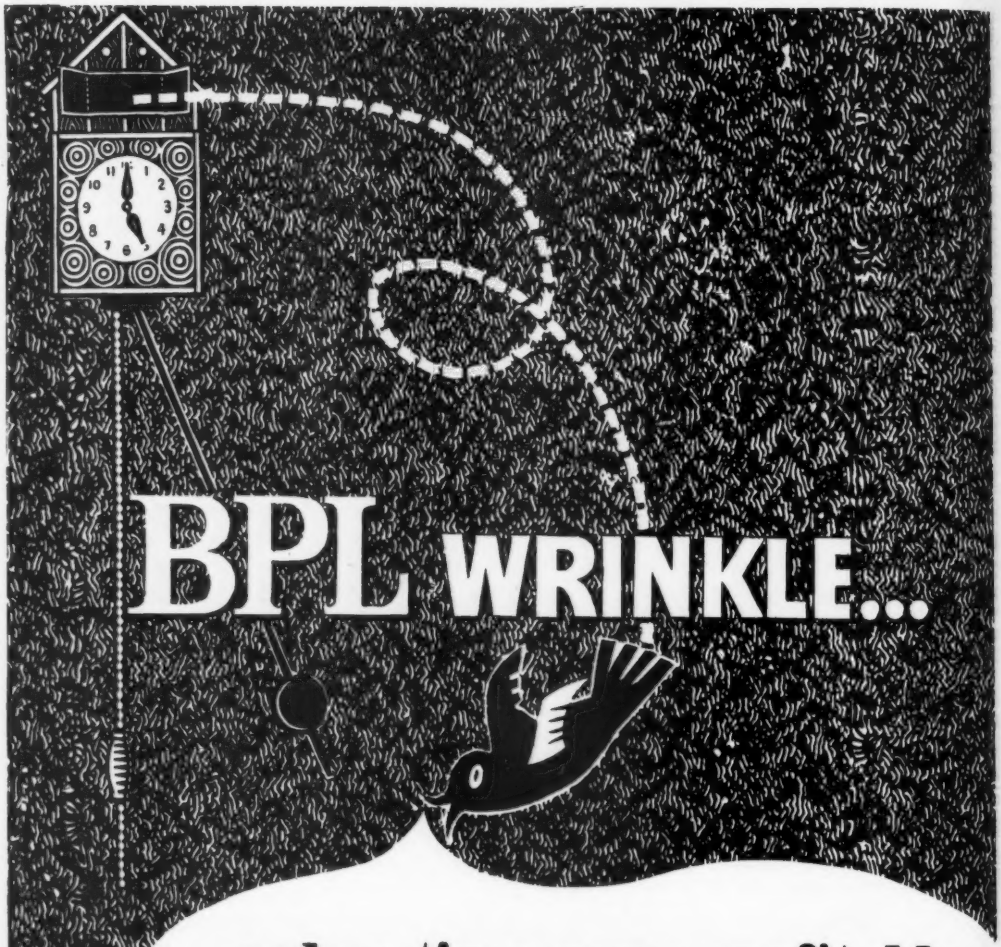

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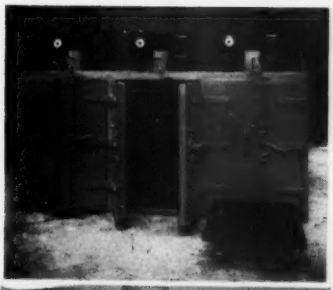

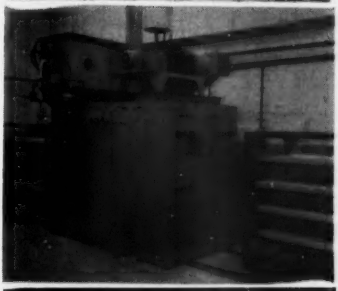

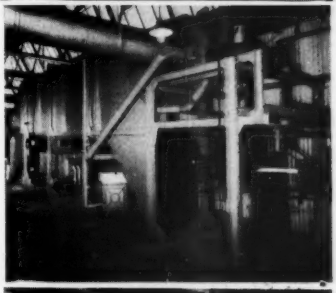

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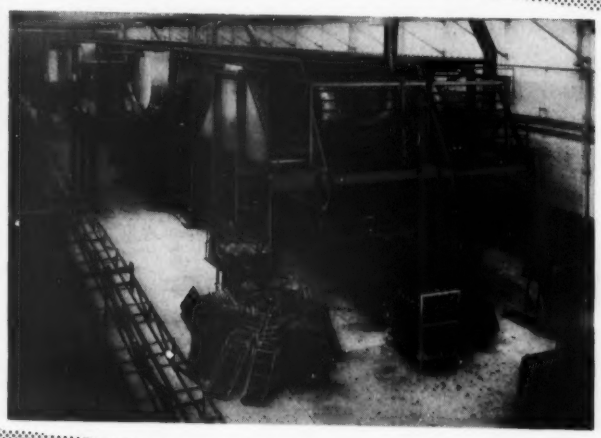

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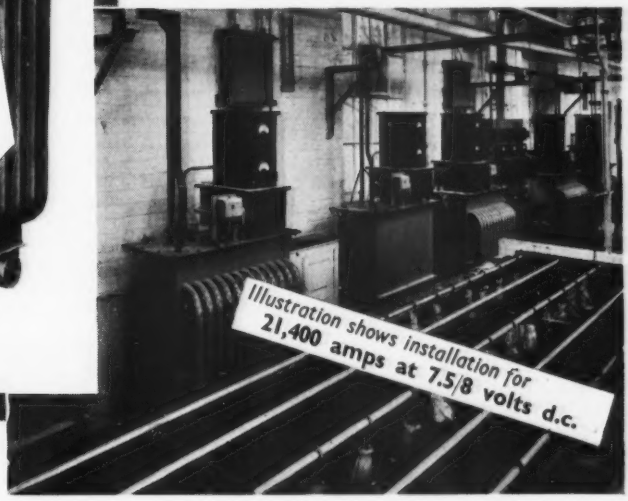

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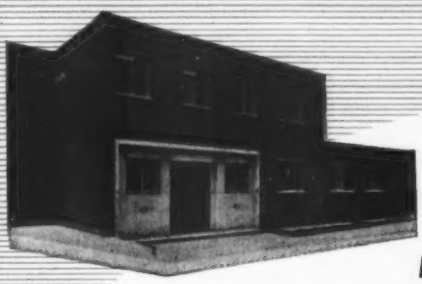

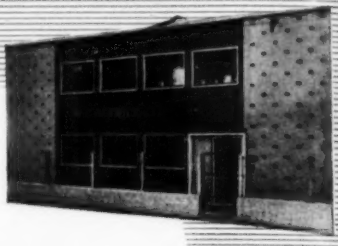

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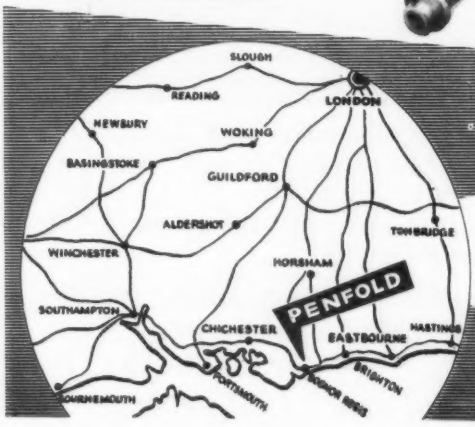

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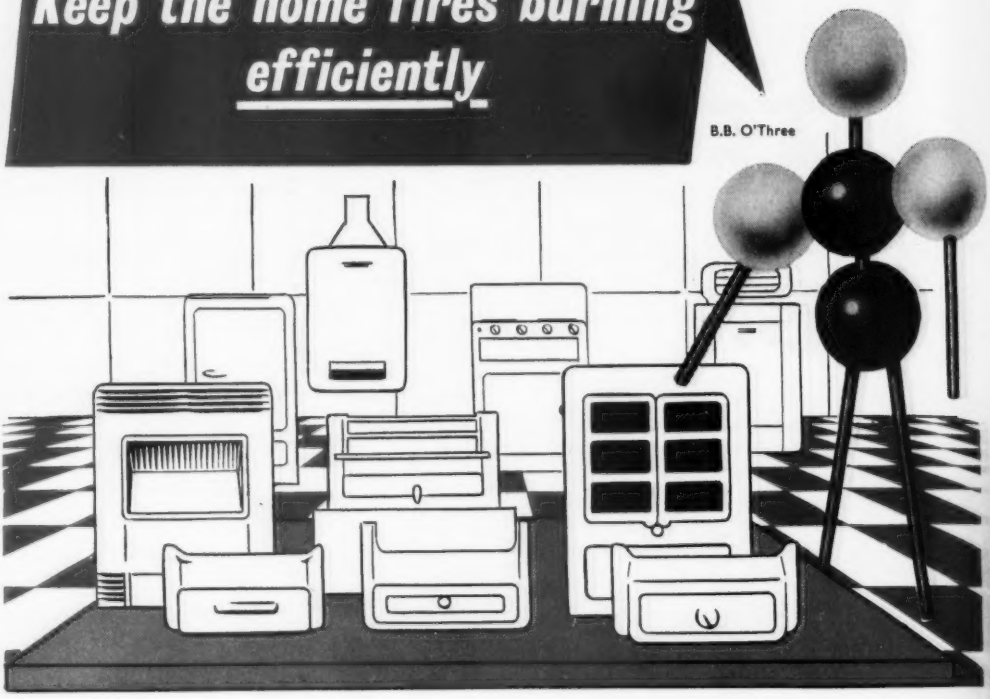

During the post-war years the fuel efficiency expert has made the British householder realise that the old-fashioned open-fire grate allows heat and therefore money to escape up the chimney at an alarming rate.* Today, rising fuel costs and the creation of smokeless zones provide further incentives to invest in modern, fuel-saving fires and efficient solid fuel appliances. Stoves and boilers of modern design offer greater warmth and comfort, as well as economy, and the wide range of vitreous enamel finishes can make them exceptionally attractive and durable.

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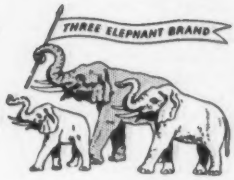

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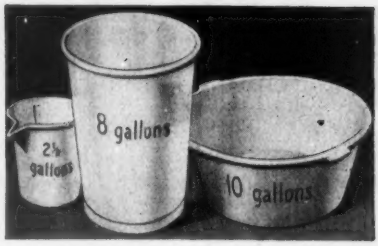

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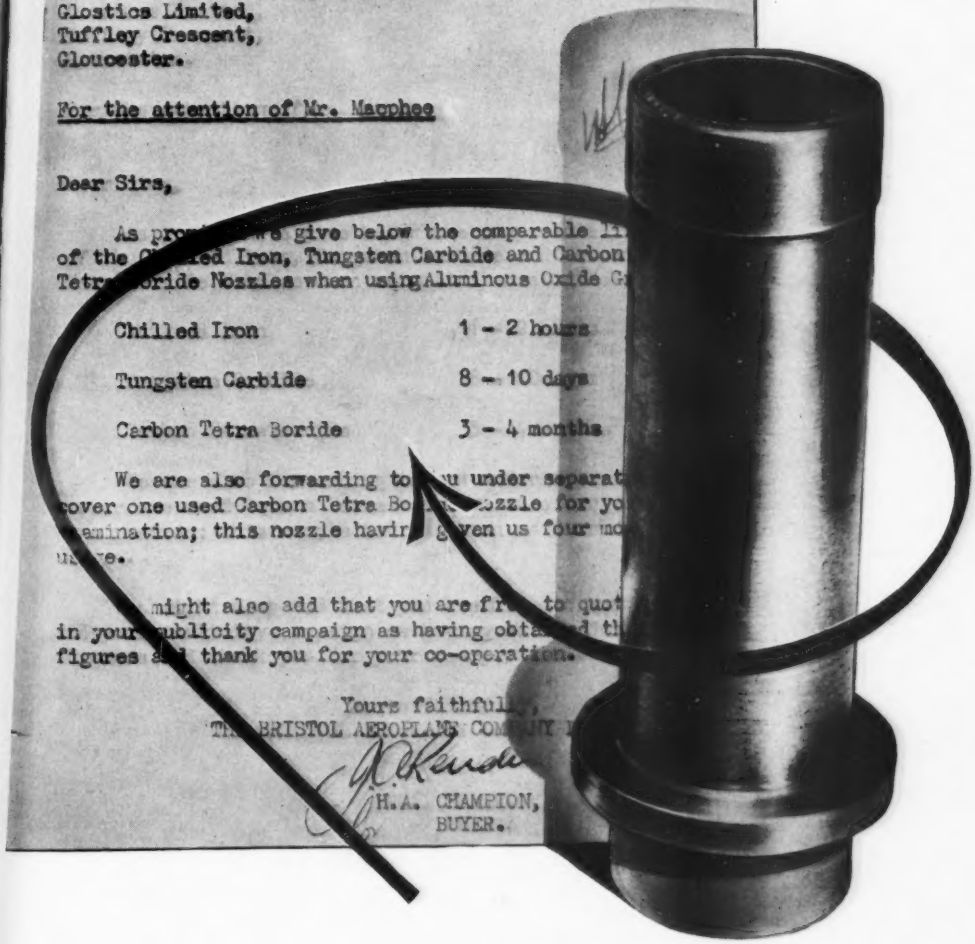

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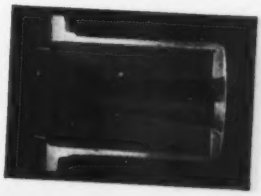

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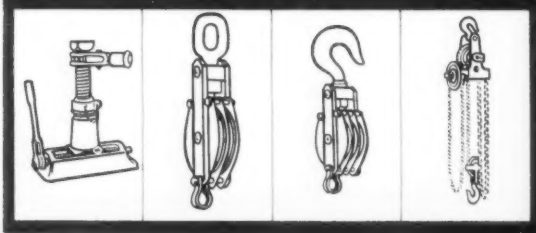
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